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THE
GEOLOGY NATURAL HISTORY
AND
PRE-HISTORIC ANTIQUITIES
OF
CRAVEN IN YORKSHIRE.

BY
L. C. MIALl,

Professor of Biology in the Yorkshire College, and Curator of the Leeds Museum.

With Geological Map and Section.

REPRINTED FROM THE THIRD EDITION OF WHITAKER'S "HISTORY OF CRAVEN."

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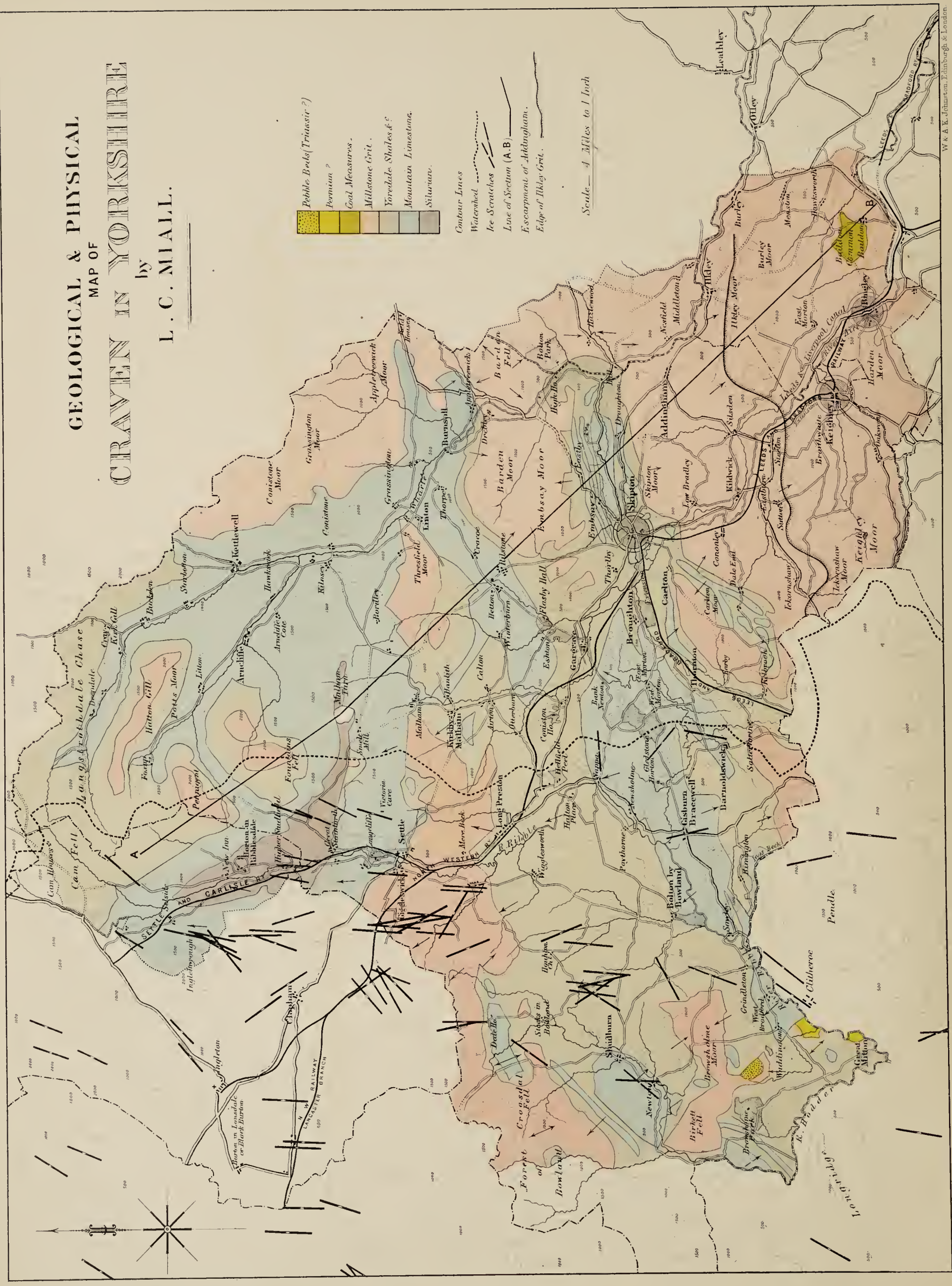
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GEOLOGICAL & PHYSICAL MAP OF CRAVEN IN YORKSHIRE by L. C. MIALl.



GEOLOGICAL SECTION OF CRAVEN IN YORKSHIRE.

Prepared for the third Edition of Whitaker's History of Craven.
(See Geological & Physical Map — Line A. B.)



Scale. 1 Inch to a Mile.

THE
GEOLOGY NATURAL HISTORY AND PRE-HISTORIC ANTIQUITIES
OF CRAVEN IN YORKSHIRE

BY
L. C. MIALl,

Professor of Biology in the Yorkshire College, and Curator of the Leeds Museum.



IN setting forth the supplementary information respecting the geology, natural history, and pre-historic antiquities of Craven which the researches of the last sixty-six years have accumulated, the writer would best have consulted his own convenience by preparing a condensed tabular statement. Such an arrangement of the materials would prevent repetition and confusion, besides permitting the introduction of facts too insignificant for separate mention. But a treatise so dry and formal would ill recommend to any but professed students the natural objects of Craven or the memorials of its early tribes. Much, too, would on this plan remain untold which is entitled by its importance to a place in a discursive topographical work. The example of Whitaker himself, and the advantage of preserving in some degree the continuity of his history, plead on the same side. I have followed in the main a topographical arrangement, tracing the three rivers of Craven from their sources to the boundary of the district, and noticing in their order of occurrence those natural features and archæological relics which best deserve attention.

For detailed geological information, the works cited in the text, and particularly Phillips's "Geology of Yorkshire," may be consulted. The maps and memoirs of the Geological Survey include as yet very little relating to Craven. Dr. Windsor's "Flora Cravoniensis" (Manchester, 1873) contains the latest and most special catalogue of the plants. The pre-historic antiquities have not been treated in any connected memoir.

GENERAL GEOLOGICAL FEATURES OF CRAVEN.

The more striking features which the rocks of Craven present have been selected for detailed description, each in its topographical connection. To those who approach the subject for the first time, the present condensed and general view may prove useful.

TABLE OF ROCKS.

Lower Coal Measures (Baildon).		
Millstone Grit (Airedale).		
Coarse Grit	} Rough Rock.	
Flagstone		190 ft.
Shales		60 ft.
Sandstones and Shales	} Middle Grits.	
Addingham Edge Grit		750 ft.
Sandstones and Shales		
Shales		700 ft.
Sandstone, in several beds, with intermediate shales (Kinder Scout Grit)		1,800 ft.
Yoredale Rocks (Penigent).		
Thin Limestone		8 ft.
Shale		10 ft.
Grey Encrinital Limestone—Main Limestone.		60 ft.
Sandstones, Shales, and Limestones.		300 ft.
Mountain or Lower Scar Limestone; in Craven usually from 600 to 1,000 ft. thick, and nearly undivided. It is estimated to amount to 3,250 ft. between Sawley and Gisburn.*		
Upper Silurian		3,000 ft. (?) visible.
Lower Silurian		10,000 ft. (?) visible.

The Silurian rocks form the natural floor to the Carboniferous rocks of Yorkshire. They are seen over a limited area in Ribblesdale and about Malham Tarn. The Silurian slates were greatly metamorphosed, upheaved, and denuded before the deposition of the Mountain Limestone.

In Craven the Mountain Limestone is nearly undivided. From 400 to 1,000 feet occur in one thick bed; above this, in the Yoredale Rocks of Phillips, are variable thin limestones. The greatest thickness of undivided limestone accessible to examination occurs near Kettlewell. Here we may suppose a deep but gently-shelving depression to have existed in the Carboniferous sea, favourable to the uninterrupted deposit of pure calcareous rock; while to the north, west, and south the greater thickness of argillaceous beds, and their variable succession, indicate comparatively shallow water. The base of the Mountain Limestone is exposed on Moughton Fell; near Crummack; at Norber; on Penigent; and in Gordale. It consists in some places of a few feet of conglomerate.

The Yoredale Rocks of Phillips constitute a group convenient for local use, but incapable of strict definition or of consistent application beyond narrow limits. With respect to their mode of origin, they imply shallow marine and estuarine conditions, and intervene chronologically, geographically, and physically between the continuous limestones and the fluviatile deposits of the Millstone Grit and Coal Measures.

The lower beds of the Millstone Grit (the Kinder Scout Grits) cover much of the high ground in Craven. South of Skipton a regular dip brings in the upper beds one after another, and the series is capped at Baildon by an outlier of the lower Coal Measures.

A small patch of Permian sandstone overlies the Carboniferous rocks below Waddow Hall, near Clitheroe,† and in Bashall Brook there is an exposure of a sandstone with a few quartz pebbles, supposed to be Triassic.‡ The Waddow Hall section shows Permian

* R. H. Tiddeman, "Geology of the Burnley Coal Field," p. 14.

† *Id.* p. 121.

‡ *Id.* p. 122.

rocks resting upon beds low in the Carboniferous series, and thus proves the great waste by denudation which occupied the interval (otherwise unrepresented in, at any rate, most British localities) between Carboniferous and Permian times. The beds removed at this point, subsequent to the local completion of the Carboniferous series, and prior to the deposition of the sandstone, amount, according to Mr. Tiddeman,* to at least 7,000 feet, leaving out the Coal Measures, which cannot be positively proved to have overlaid the spot. The high inclination of the Permian rocks (as also at Westhouse, near Ingleton), and their almost complete destruction, testify to later displacement and waste.

The original lie of the Carboniferous rocks of Craven has been greatly disturbed by the complex system of faults known collectively as the Craven Fault (see Map, Section, and pp. 14, 15). In South Craven a series of approximately parallel anticlinals, varying in direction from N.E.—S.W. to E.—W., brings up the limestone between the shales and grits of the Yoredale and Millstone Grit series, while these latter rocks are often thrown into synclinal basins or troughs.

Craven is, on the whole, thickly covered with glacial deposits, which within this area consist almost wholly of till—a tenacious clay containing scratched and subangular stones, local or travelled. In Airedale, but somewhat beyond the limits of Craven, gravelly and partially-stratified glacial deposits begin to appear, while south and east of Leeds all signs of an ice-sheet are scanty and obscure. The glacial till of Craven extends eastward as far as the vale of York, where it gives place to mounds of rounded pebbles, gravel, and sand, with indications in places of a stratified arrangement. The glacial striæ marked upon the map were noted or collected by Mr. Tiddeman.†

WHARFDALE.

Upper Wharfedale.—The sources of Wharf, like those of all the Craven rivers, lie among the hills in the north of the district, close to the dividing ridge which throws off the waters of Lancashire to the west, and those of Yorkshire to the east. From the wet and desolate moors of Dod Fell, Cam Fell, and Penigent many small rivulets spring, and unite on the eastern side of the watershed into two main streams. The more northerly of these bears the name of Wharf from its very beginning. It flows along the deep and secluded Langstrothdale, gradually sweeping southwards, and cutting its channel deeper and deeper through the rocks until it reaches the lower scar limestone about Oughtershaw. In Deepdale the scenery changes. The brown moors, ill-drained, clothed with heather, sedges, and moss, and strewn with grit boulders, separate a little on either hand, and disclose a narrow glen with precipitous rocks, bright green pastures, and scattered trees. Below Kettlewell the Wharf is joined by the Skirfare, descending from Littondale. Some four miles above the junction, in the valley of the tributary stream, lies the

* "Geol. of Burnley Coal Field," p. 122.

† *Geol. Journal*, vol. xxviii. p. 489 (1872).

beautiful village of Arncliffe. Here may be found in perfection the rich flora of the mountain limestone, varied by great differences of elevation and shelter. The limestone, which in Langstrothdale was exposed only towards the bottom of the valley, gradually rises into the great white scars of Arncliffe Clowder, Hawkswick Clowder, Hard Flask, and Kilnsey Crag. It is probable from a comparison of measurements that near the junction of the Wharf and the Skirfare the entire thickness of the limestone is penetrated by the river, and that a section unobscured by alluvial deposits would expose Silurian slates in the bed of the stream.* Beyond this point the limestone sinks again, being apparently carried down by a succession of throws which may represent the divisions of the Craven Fault. The Wharf flows through mountain limestone, without proved interruption, from Deepdale to below Burnsall, and over the greater part of this distance the country to the west, between the Wharf and the Aire, is overspread by the same rock. On the east, the millstone grit ranges of Great Whernside, Coniston Moor, and Grassington overhang the river at no great distance.

Dowkerbottom Cave.—In the floor of this cave, whose situation is described in the text of Whitaker, have been discovered numerous Romano-British relics, human skeletons, bones of various recent animals, and a fragment of an antler of the extinct Irish elk.† A systematic re-examination of this and other ossiferous Craven caves would doubtless yield important results. The exploration of the Victoria Cave, near Settle, testifies to the rich accumulation of ornaments, implements, and bones which may lie buried in the floor of an obscure limestone cavern, while a special palæontological interest attaches to the determination of those pre-glacial and inter-glacial species of mammalia, whose remains, casually lodged in caves and fissures, may have escaped destruction when the ice-sheet swept clear the surface of the north of England.

Kilnsey Crag.—Close to the village of Kilnsey is a limestone cliff, rising directly to 170 feet, and at one point overhanging its base nearly forty feet. When Professor Phillips wrote his useful account of the “Rivers, Mountains, and Sea-Coast of Yorkshire,” no doubt was entertained that Kilnsey Crag, like Malham Cove and Giggleswick Scar, was an ancient sea-cliff.‡ Geologists of a later date, succeeding to a rich inheritance of knowledge, of which the chief share has been furnished by the labours of others, may, without taking to themselves any great share of merit, correct the natural but often mistaken hypotheses of the founders of their science. In not a few places we are tempted to qualify Professor Phillips’ statements as to the natural agents which have shaped the hills and valleys of Craven. In the case of these limestone cliffs, their occurrence at very different elevations, so that almost every one would require a separate and long-maintained level of sea for its production, their situation in remote winding valleys with a constant fall of level, and the universal absence of

* J. R. Dakyns, *Proc. W. R. Geol. Soc.*, N.S. vol. i. p. 159 (1877).

† “On the Geological and Archæological Contents of the Victoria and Dowkerbottom Caves in Craven.” By Henry Denny, *Proc. W. R. Geol. Soc.* vol. iv. p. 45 (1860). “Further Explorations in the Dowkerbottom Caves, in Craven,” by James Farrer, M.P.; with remarks by Henry Denny. *Ibid.* vol. iv. p. 414 (1866).

‡ “The great inland cliffs, which are among the most striking phenomena of Yorkshire, only differ from sea-cliffs, because the water no longer beats against them.”—*Op. cit.* p. 11.

raised beaches, all require us to seek a denuding agent more appropriate to their production than the waste of the sea. The natural operations in daily exercise among the limestone hills of Craven supply an alternative explanation. Atmospheric waste—rain, streams, and frost each exerting an important and characteristic influence—is visibly at work, and we may, without exaggeration, affirm that here at least it has effaced the marks of previous marine denudation.

While we look to atmospheric waste as the cause of the rock-sculpture of Craven, it is not unimportant to consider the peculiar local conditions under which it has acted. The mountain limestone is a well-jointed rock, intersected by rectangular planes of division, which give the mass a tendency to break up into rectangular prisms. These joints, when freely exposed to the action of the weather, become enlarged, and produce the “helks” or prismatic columns so often seen on the edge of a limestone scar. When the beds of limestone are horizontal, or inclined at low angles, as is generally the case in Craven, the joints occupy a vertical position, and the rock, under suitable conditions of elevation and exposure, weathers to a vertical face, interrupted more or less by steps, according as the stratification locally overpowers the jointing. Frost is commonly in such cases the primary agent of denudation, and streams play the subordinate part of removing the fallen pieces. Where there is no stream powerful enough to clear the *débris*, we get “scree” at the base of the cliff—angular fragments, accumulated sometimes in such quantity as to bury the solid rock. Elsewhere the solvent power of water containing carbonic acid is conspicuous. A solid scar may be fretted away to a pile of fantastic pinnacles, or may retreat with immeasurable slowness, as film after film is dissolved by the rain. Instances might be cited of the excavation by surface-water of deep chasms with vertical and fluted sides. Still more numerous are the examples of precipitous ravines, whose existence is traced to the falling in of caverns hollowed out by subterranean rills.

The cliffs of the Craven hills are their noblest feature. In general, the limestone, like other well-bedded and well-jointed rocks, yields forms too definite and too often repeated to give pleasure. We miss the subtle curves and the ever-changing profiles of a hill-country carved out of volcanic or metamorphic rocks, and find, instead of the endless variety of the Highlands or Lake-country, a succession of flat-topped or rounded uplands intersected by abrupt gorges.

In some cases the great lines of ancient disturbance have produced marked features of the landscape. Though not often plainly traceable across the country, dislocations conspicuous to the eye are to be found more frequently than in most parts of England. Along the Craven Fault, as at Malham Cove, there are sheer cliffs almost directly on the line of upheaval. Elsewhere the cliff, while remaining vertical, has been wasted back far from the actual disruption. It is not impossible that at Kilnsey, too, a line of fault originally determined the existence of the crag, which has since receded by weathering to its present position.

Grassington Mines.—On Grassington Moor extensive and valuable veins of galena have long been worked. Unlike the mining-fields of North Yorkshire, which are almost restricted to the limestone, the productive veins at Grassington, Pateley Bridge, and Cononley chiefly

traverse grit, plate and shale. The richest veins seem to be enclosed by cheeks of grit, or of grit on one side, and some other rock on the other. Where the cheeks become argillaceous or shaly, the lode usually breaks up, or falls to an inconsiderable thickness. Where the measures are much crushed by faults, as by a broken anticlinal, the lode is apt to split up into strings, and the galena is more or less converted into carbonate of lead. Minium, calamine, and pyromorphite (lead phosphate) are occasionally met with at Grassington, and native lead is said to have been found.*

In the "dowk," or non-metallic vein-stuff of Grassington Moor, numerous minute organisms have been detected by the close scrutiny of Mr. Charles Moore.† All the species cited in the subjoined list may be of Carboniferous age, and were in all probability already fossil when they were washed into the fissures. Rhætic and Liassic species, which are common, under similar circumstances, in the Mendips and South Wales, are rarely met with in the mineral veins of the North of England. The terrestrial and fluviatile forms (marked F in the list) present difficulties. Mr. Moore supposes that they are derived from a fresh-water Carboniferous limestone, but there is no direct evidence as to the existence of such a deposit. The species marked P are only known from their occurrence in mineral veins.

Seeds?	<i>Cythere Muensteriana</i> , J. & K.
Plants, impressions on shale.	—— n. sp.
<i>Nodosaria radicular</i> , L.	<i>Leperditia Okeni</i> , Münst.
—— sp.	<i>Bryozoa</i> , various sp.
<i>Involutina polymorpha</i> , Terquem.	<i>Discina nitida</i> , Phil.
—— <i>aspera</i> , Terq.	<i>Leptæna</i> , sp.
—— <i>nodosa</i> , Terq.	<i>Lingula</i> , sp.
—— <i>vermiformis</i> , Brady (P.).	<i>Terebratula hastata</i> , Phil.
—— <i>incerta</i> , Brady (P.).	<i>Thecidium</i> ?
—— <i>recta</i> , Brady (P.).	<i>Zellania</i> ? sp.
—— <i>cyindrica</i> , Brady (P.).	Bivalves, fragments.
Corals, sp.	<i>Hydrobia</i> , n. sp. (F., P.).
<i>Encrinites</i> , sp.	<i>Lithoglyphus</i> , sp. (F., P.).
<i>Echinodermata</i> , sp.	<i>Planorbis Mendipensis</i> , Moore (F., P.).
<i>Echini</i> , remains.	<i>Valvata anomala</i> , Moore (F., P.).
<i>Serpula</i> .	<i>Dentalium inornatum</i> , McCoy.
<i>Serpulites</i> .	<i>Turbo</i> , sp.
<i>Crustacea</i> (fragment).	<i>Cladodus</i> , teeth.
<i>Bairdia plebeia</i> , Reuss.	<i>Orodus</i> , teeth.
<i>Beyrichia</i> .	<i>Petalodus</i> , teeth.
<i>Cythere bilobata</i> , Münst.	<i>Psammodus</i> , teeth.
—— <i>nigrescens</i> , Baird.	Jaw of fish, portions.
—— <i>munda</i> .	Fish-scales.
—— <i>aqualis</i> , n. sp. (P.).	Fish-vertebræ.
—— <i>intermedia</i> , Münst.	Conodonts.
—— <i>fabulina</i> , J. & K.	Coal or coal-like shale.
—— <i>ambigua</i> , Jones.	

Mountain Limestone of Thorpe.—Close to the old and half-deserted village of Thorpe, near Burnsall, the traveller cannot fail to remark the singular conical Limestone hills which range beneath the slightly higher Grit-edge of Rilston Moor. The Limestone is both contorted and faulted, so that it is not easy, in the absence of a detailed survey, to ascertain

* Stephen Eddy, "On the Lead-Mining Districts of Yorkshire," Report of British Association, 1858, ii. p. 167.

† "On Mineral Veins in Carboniferous Limestone," Brit. Assoc. Report, 1869, i. p. 371, &c.

its precise relation to the plateau of Millstone Grit. It is probable, however, that the line of junction is close to a line of fault. Here have been found workable veins of lead. Patches of the Limestone are extraordinarily rich in fossils, and the writer has gathered examples of the following rare species :—

Spirifera triangularis, Mart.
S. subconica, Mart.
Spiriferina cristata, Schl.
Retzia radialis, Phil.
Productus ermineus, D. Kon.

Chonetes papilionacea, Phil.
Cyrtina septosa, Phil.
Lingula mytiloides, Sow.
Murchisonia angulata, Phil.
Turbo semisulcatus, Phil.

The quarry at Cracoe Swinden, close to the coach-road between Skipton and Kettlewell, has also yielded many good fossils; among others :—

Griffithides globiceps, Port.
Nautilus cariniferus, Sow.
Orthoceras reticulatum, Phil.
Goniatites intercostalis, Phil.
Pleurotomaria flammigera, Phil.

P. tumida, Phil.
Metoptoma elliptica, Phil.
Patella retrorsa, Phil.
Bellerophon Woodwardi, Sow.
Pecten interstitialis, Phil.

The occurrence of fossils in the Mountain Limestone follows no general law of distribution which has hitherto been ascertained. The species seem to be mixed indiscriminately, and the rock proves barren or productive to the collector according as its texture is favourable or not to the preservation of organic remains. We may, however, occasionally trace the temporary predominance of a particular class of marine animals in a particular spot of the ancient Carboniferous sea. Thus, at Thorpe a densely-populated nest of *Productus giganteus* is found; a band rich in the same species occurs at Slaidburn, in Bolland, and is often met with at or near the top of the Lower Scar Limestone. A little patch of limestone near the calamine pits at Malham has yielded hundreds of trilobites (*Phillipsia gemmifera*); while the quarries about Clitheroe and Chatburn are rich in crinoidal heads, elsewhere very uncommon in the north of England.

Rilston Fell and Simon Seat.—The Kinder Scout Grits (see table on p. 4) occupy the high ground between Rilston and Burnsall, and extend continuously to Crookrise and Embsay Moor, where they are thrown off by the anticlinal of Skibeden. Over this tract they form a basin, and dip inwards on all sides. Across the Wharf we find the disposition of the same beds reversed in the hill known as Simon Seat. Here the grits occupy a dome, and dip away on all sides from the centre. On the summit of the hill the underlying shale is exposed, and a number of swallow-holes show that the limestone which composes the mass of the interior lies at no great distance from the surface.*

Sepulchral Barrow at Rilston.—Canon Greenwell remarks† that Craven abounds in remains of pre-historic times. Weapons and implements of stone and bronze have occurred at or near Rilston, and besides the sepulchral mound next to be described, barrows still exist in the neighbourhood. Some of these “yet remain unopened, but the greater number have been more or less destroyed by curiosity-hunters, without any note of their construction

* J. R. Dakyns, Brit. Assoc. Report, 1873, ii. pp. 78-9.

† “British Barrows,” p. 374 (Oxford, 1877).

or contents having been preserved." There are also many hill-terraces, supposed by Canon Greenwell to be "clearly of artificial origin."

A very interesting barrow was opened by Canon Greenwell at Scale House, near Rilston. It had been previously dug into, and the contents were disturbed and injured in consequence. The barrow was thirty feet in diameter and five feet high; it was made of clay, and was encircled by a shallow trench. "Immediately beneath the surface of the barrow, at the centre, there was a layer of flat stones, about six feet in diameter, carefully arranged. Under these stones the clay was firmly compacted, and rested upon a thin stratum of dark-coloured earthy matter, which was very fully charged with charcoal. Beneath this again was a layer of finer clay, or rather of clay which appeared to have undergone a process of tempering. Below this finer clay, and carefully embedded in it, was an oaken coffin laid upon clay, and to some extent supported by a few stones, the whole being placed in a slight hollow sunk below the surface of the ground. The coffin was formed of the trunk of an oak-tree split in two and then hollowed out. It was $7\frac{1}{4}$ ft. long and 1 ft. 11 in. wide; the trunk had been cut off at each end and then partially rounded, but on the outside no attempt at squaring or other workmanship had interfered with the natural surface of the timber. The hollow within was 6 ft. 4 in. long and 1 ft. wide, roughly hewn out, and still showing the marks of the tool employed; the ends inside were finished off square. It was not possible to make out the precise nature of the tool which had been employed, but the appearances warranted the conclusion that it had been a narrow-edged metal implement. The coffin was very much broken in consequence of the disturbance before mentioned; it was, however, still sufficiently entire to allow its arrangement to be seen. It was laid north and south, having the thicker end—where the head of the enclosed body had no doubt been placed—to the south. The body had entirely gone to decay, and nothing was observed which might have formed a constituent part of it, except an unctuous whitish substance, which chemical analysis has proved to be of animal origin. The corpse had been enveloped in a woollen fabric, enough of which remained to show that it had reached from head to foot. It was very rotten, and partly on that account, and partly by reason of the infiltration of earth which had found its way into the coffin through the breakage occurring when the barrow was first opened, and which had become mixed up with the cloth, it was impossible to recover any but small pieces of it, or to prove whether the body had been laid in the grave in its ordinary dress or simply wrapped in a shroud. It is on the whole probable that in this case, as in those of some tree-burials discovered in Denmark, the person had been interred in the dress worn by him in daily life, though perhaps it may be alleged that the absence of anything like a button or other fastening is rather against that view. The material is now of a dark-brown colour due most likely to the tannin in the oak of the coffin; whilst to the acid generated in the decaying wood, and set free by the percolation of water, is perhaps to be attributed the total disappearance of the bones. There was nothing found in the coffin besides the woollen stuff; nor, with the exception of pieces of charcoal and some burnt earth, was anything met with foreign to the ordinary material of the rest of the barrow.

"In the absence of any associated articles in the coffin, or of potsherds or flints in the mound itself, it is difficult to assign a precise date or period to this remarkable burial. But

if we take the general shape and construction of the barrow into consideration, as also the encircling ditch, the presence of charcoal and other indications of burning, I see no reason for hesitating to refer it to the people whose usual custom it was to place the body of the dead person in a stone cist or in a grave within the barrow; merely supposing that in this and in a few other instances they departed from their ordinary practice in favour of a wooden receptacle. And when we compare this burial with some others found in this country, and with those which have occurred in Denmark, we can further have little doubt about attributing it to the time when bronze was in use for weapons and implements. The mode of interment in the hollowed trunk of a tree placed within a barrow is no doubt rare, although burials in cleft and hollowed trees placed in the ground without any superincumbent grave-mound are not so uncommon; many of these, however, are not to be referred to a very early period, and indeed probably belong to a time several centuries after the Christian era."

*Carboniferous Rocks of South Craven.**—The general arrangement of the Carboniferous rocks in this part of Craven may be illustrated by supposing them to have been subjected to pressure in two directions, which are approximately N.S. and E.W.† Two sets of folds have thus arisen, which cross at right angles, and produce by their intersection a well-marked basin and a well-marked dome. Beneath the escarpment of the Kinder Scout Grits on Burnsall, Thorpe, and Rilston Fells is a small exposure of the shales called by Phillips the Craven Shales, and ranked by him as equivalents of the Yoredale Rocks. On the southern edge of Embsay Moor the same beds are seen more completely, and here they are found to include two limestones. The shales occupy the comparatively low ground, which surrounds the limestone boss of Skibeden, and underlie Bolton Woods. On the steep river-bank opposite Bolton Woods we see them again in section. Immediately behind (that is, to the east of the river) a fault running N.E.—S.W., cuts off the shales, and the lower beds of the Millstone Grit form the high ground about Storrihs and Bolton Park.

Crossing Rombald's Moor from Skipton to the S.E., we traverse in nearly regular succession all the beds of the Millstone Grit series. As a rule, the sandstones form conspicuous features along the sides and top of the moor, while the intermediate shales can be traced by the pastures of the lateral slopes, or by wet depressions overgrown with sphagnum moss at greater heights. The prevailing strike, which is nearly E.—W. at Skipton, gradually assumes a N.E.—S.W. direction as we go S.E. Ascending from Skipton, we first meet, on the edge of the moor, the so-called Yoredale Grit, which in this part of Yorkshire is merely a subordinate and variable division of the next member of the series. The more conspicuous sandstone above it, the Kinder Scout Grit of Derbyshire, forms the top of the ridge. It is here inclined to the S. at an angle of about 20°—a steep dip, which soon carries the rock down to the level of the river Aire. Near Cononley a fault, running across the valley, causes the beds to be repeated, and the Kinder Scout Grit

* See J. R. Dakyns on the "Geology of Keighley, Skipton, and Grassington," *Geol. Mag.* vol. iv. p. 346 (1877).

† See Prof. Hull on the "Relative Ages of the Leading Physical Features and Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire," *Q. J. Geol. Soc.* vol. xxiv. pp. 323—335 (1868).

reappears on Kildwick Moor, and forms the steeply-inclined sandstone shelf which slopes downwards to the village of Kildwick. A much divided and variable series of sandstones, flags, and shales, the Middle Grits, occupies the slopes about Silsden, and much of the lower ranges of Airedale as far as Shipley. On the other side of Rombald's Moor, the Middle Grits form the precipitous crags of Ilkley, Otley, and Bramhope. They may be conveniently studied above Sutton, along Addingham Edge, and in Holden Gill, near Silsden. The Rough Rock, the highest member of the Millstone Grit, rises to upwards of 1,300 feet on Rivock Edge, and ranges across the moor eastwards to the lower slopes of Otley Chevin. On Baildon Common it forms a conspicuous escarpment, and is extensively quarried. South of Shipley it appears as a low cliff at Windhill Crag, and is then cut off by a fault which brings against it the lower Coal Measures. On Baildon Hill and at Rawden are outliers of the Halifax Hard and Soft Beds, the lowest seams of the neighbouring coal-field.

Vegetation of the Millstone Grit.—The sandstones of the Millstone Grit are usually occupied by heather, coarse grasses, and such plants as love a peaty, ill-drained, and innutritious soil. Ericaceous shrubs, *Calluna vulgaris* (ling), *Erica tetralix*, *E. cinerea*, *Vaccinium myrtillus* (bilberry), are the predominant species. *Vaccinium vitis-idaea* and *V. oxycoccus* are found in a few places near Ilkley. *Empetrum nigrum* (crowberry) is often abundant. *Drosera rotundifolia* (sun-dew) and *Narthecium ossifragum* are found in swamps, while *Montia fontana* and *Stellaria uliginosa* fringe the rills. Of the grasses and sedges, *Juncus squarrosus*, *Scirpus cæspitosus*, *Eriophorum vaginatum*, *Festuca ovina*, *Nardus stricta*, and *Aira flexuosa* are the most characteristic. *Polygala vulgaris*, *Teucrium scorodonia*, *Sagina procumbens*, *Potentilla tormentilla*, *Rubus chamæmorus*, *Digitalis purpurea* (foxglove), *Galium verum*, *G. saxatile*, and *Myosotis versicolor* frequent the drier ground, or spring up where the heather has been cleared. Copses of oak fringe the moor; alders line the streams which flow down to the Aire and Wharf; the birch and rowan-tree are as plentiful at low elevations as the hazel and ash in the thickets of limestone hills. *Chrysosplenium*, *Caltha*, *Cardamine sylvatica*, *Parnassia*, *Crepis paludosa*, *Spiræa Ulmaria*, *Ænanthe crocata*, and *Equisetum Telmateia* haunt the wooded "gills." Many ferns are found: bracken among the heather; *Botrychium lunaria* locally on dry and stony edges; *Ophioglossum*, abundant, but hard to find, in the richer pastures; *Polypodium dryopteris*, *P. phegopteris*, *Lastræa recurva*, and *L. oreopteris* in the woods. *Lycopodium clavatum* and *L. alpinum* occur near Ilkley. The chief mosses are: *Sphagnum cymbifolium* and *acutifolium*, *Weissia controversa* and *cirrhata*, *Bartramia fontana*, *Seligeria recurvata*, *Ceratodon purpureus*, *Didymodon rubellus*, *Tortula subulata*, *Racomitrium aciculare* and *lanuginosum*, *Zygodon Mougeotii*, *Dicranum scoparium* and *heteromallum*, *Polytrichum commune*, *juniperinum* and *piliferum*, *Ptychomitrium polyphyllum*, *Hypnum cupressiforme*, *elegans*, *undulatum*, *lorcum*, *denticulatum*, *splendens*, and *fluitans*. *Cetraria aculeata*, *Cladonia rangiferina* and *coccifera* are the common lichens of the heather; *Endocarpon smaragdulum*, *Biatora polytropia*, *Lecidea albo-cærulescens* and *contigua*, *Parmelia saxatilis*, *olivacea*, and *atra*, *Jungermannia Taylora* and *albicans* are also more or less characteristic.*

* I have found useful lists of Craven plants, and remarks on their distribution, in various papers and books by Mr. J. G. Baker and Dr. Carrington.

At considerable elevations the flora of the sandstones becomes very meagre. Thus the summit of Ingleborough presents only stunted plants of *Juncus squarrosus*, *Luzula campestris*, *Galium saxatile*, and *Festuca ovina* (*vivipara*).

The dull brown of a Grit moor, varied with pink when the heath is in bloom, distinguishes it at a glance from the short, fresh turf of the Mountain Limestone, thickly strewn with yellow pansies, orchids, and primroses. On some of the Craven hills the junction of a sandstone peak with a limestone plateau, or the opposition of a range of grits and shales to a limestone scar, can be detected at a distance of some miles, and by the colour no less certainly than by the form of the ground. In Charlotte Brontë's novels the Millstone Grit scenery is vividly described, in its beauty as in its desolateness; and the unimportant change of one word—sandstone for granite—renders the sketches of "Jane Eyre" faithful pictures of the moors of South Craven.

Pre-historic Remains on Rombald's Moor.—Several of the larger rocks on the moor above Ilkley exhibit the rude sculptures known as "cup-and-ring marks." Speculation has done what it can to elucidate these strange symbols, but as yet without the least success. It seems probable that they are of pre-historic antiquity: they are certainly of very wide distribution, and traceable on the rocks of many parts of Europe.* Casts of the Ilkley carvings, procured and given by Mr. John Holmes, are preserved in the Leeds Museum.

Local antiquaries have freely interpreted the more remarkable tumbled blocks of Rombald's Moor as Druidical remains,† and have even described as British huts the bell-pits excavated for working shallow coals on Baildon Common.‡ Pre-historic antiquities of a less disputable kind, barrows and stone circles, are to be found on the moor, and some of these have been dug out, but without the critical investigation which modern archæology exacts.

A I R E D A L E .

Malham Tarn.—The second Yorkshire river whose course we have to trace rises south of the Wharf, and in the midst of that Mountain Limestone area which the Wharf only reaches after it has traversed the greater part of Langstrothdale. One of the chief springs of the Aire is the water that escapes from Malham Tarn, loses itself within half a

* Stuart's "Sculptured Stones of Scotland;" Sir J. Y. Simpson, "Archaic Sculpturings," and *Proc. R. Soc. Ed.* vol. v. p. 52; George Tate, "Ancient British Sculptured Rocks of Northumberland" (*Trans. Berwickshire Naturalists' Club*, vol. v. p. 137); "Incised Markings on Stone," published by direction of Algernon Duke of Northumberland; Bateman's "Ten Years' Diggings," pp. 172, 178; Greenwell's "British Barrows," pp. 7, 341, 422; "Rambles on Rombald's Moor," by C. F. and W. G., part iii. (Wakefield, 1869).

† "Rambles on Rombald's Moor."

‡ Wardell in "Reliquiæ Antiquæ Eboracenses" (Leeds, 1855), p. 92. For an elaborate case of the same thing, see a paper by the Rev. S. F. Surtees, in *Proc. W. R. Geol. Soc.* (1870).

mile of its source in a fissure, and reappears at Aire Head. Another main feeder collects the waters of nameless subterranean streams, and emerges at the foot of Malham Cove. A third affluent rises north-east of the tarn, rushes through the wild cleft of Gordale, and joins the other streams below Malham.

It is not without surprise that the geologist acquainted with the jointed and fissured character of the Mountain Limestone of Craven sees a considerable body of water collected high up on the plateau of Malham Moor.* The shallow basin of the tarn is in reality excavated, not in the limestone but in Silurian slates, which are here exposed along a narrow strip of ground, bounded on the north by the base of the limestone, and on the south by the North Craven Fault, which carries the Silurian rocks and overlying limestone down several hundred feet. This exposure of the slates is greatly obscured by glacier-drift. The tarn is about a mile across, but nowhere exceeds fourteen feet in depth. Part even of this trifling depth is due to an artificial dam. It abounds in fish, the common yellow or brown trout of the Aire being taken in considerable numbers, and up to a good weight. The silver trout is less plentiful; perch are also found. It is plain, from the evidence collected by Whitaker, that the tarn has long been a fishing-ground, and that it was in 1175 already known and valued as such. Yet it is hard to suppose that it is naturally stocked, and that the fish made their way "by secret sluice" from the waters of the Aire, 600 feet below the tarn in vertical height, and distant more than a mile. The silver trout, besides, does not inhabit the Aire. Transport of ova may have been effected by such natural agents as aquatic birds, but most likely the tarn was stocked long ago by man. The trout present an unexplained peculiarity in the frequent decay of the gill-cover. About one in twenty of the silver trout, and one in thirteen of the yellow trout, have the gill-covers defective on one or both sides.†

Silurian Rocks and Mountain Limestone of Malham.—Underlying all the Carboniferous rocks of Craven are the Silurian slates, which are visible in Chapel-le-dale and Kingsdale near Ingleton, pass along the south-western base of Ingleborough, and are extensively exposed about Austwick, Wharfe, and Horton-in-Ribblesdale. Thence a narrow strip may be followed by Stainforth, Capon Hall, and Malham Tarn to Gordale. The denuded surface of the slates once formed a slightly irregular plane, upon which the solid limestones were deposited in ancient seas. The Craven Fault has disturbed and complicated this simple disposition. The slates are now cut off on the south by the North Craven Fault, which brings against them the Mountain Limestone, here lying between the two parallel faults, and sloping steeply to the south. The plane of junction is thus not only fractured but inclined in different directions. We find the visible base of the Carboniferous series rise from 800 feet above sea-level at Selside to 1,160 feet on Moughton Fell, and to upwards of 1,250 feet on Malham Moor. On Malham Moor the slate area varies in breadth from a few yards at Capon Hall to nearly a mile at the tarn. Eastwards it narrows again,

* "It is not the least curious circumstance about this place that, on a bottom so cleft and shattered, a basin should have been left capable of retaining a sheet of water not less than a mile in diameter—for such is Malham Tarn."—Whitaker, *ante*, p. 267.

† Information supplied by Walter Morrison, Esq., of Malham House, in 1868.

and is cut off immediately beyond Gordale. The area is much obscured by drift, and in two places only can the slates be fairly seen—viz., at Capon Hall and at Gordale. Here the Coniston Flags (Upper Silurian) appear with a steep dip S.S.W.*

Between the slates and the limestone an irregular conglomerate is often found, containing pebbles of Silurian rocks imbedded usually in the lowest beds of the limestone, but sometimes in a sandy matrix. This deposit is well seen at Thornton Force in Kingsdale, at Norber, at Austwick Beck Head, on Moughton Fell, at Capon Hall, in Gordale, and, farthest to the east, in a gorge about a mile and a quarter east of Gordale.

The Mountain Limestone about the sources of the Aire is massive and nearly undivided, reaching a thickness of 800 feet.

Craven Fault.—The regular sequence of the Carboniferous rocks in Craven is strikingly deranged by the extensive and complex dislocation known as the Craven Fault. At Ingleton the total displacement occasioned by two parallel and adjacent faults amounts, according to Phillips, to 3,000 feet; the real amount is probably greater. Further eastwards the faults begin to diverge. The northern branch crosses the Ribble at Stainforth, and is continued by Malham Moor to Gordale. The amount of throw diminishes towards Wharfedale, and the fault has not been detected beyond Threshfield. The southern primary branch passes south-east to Giggleswick, where it opposes the lower beds of the Millstone Grit to the Mountain Limestone. At Settle it divides. One line of dislocation, the Mid Craven Fault, turns sharply to the east, and may be traced along the hilly road which leads from Settle through Stockdale to Malham by the contrast in form and colour of the widely different rocks thus brought into contact. On the north the traveller sees the white scars of Attermire, the “helks” of fissured and weathered limestone, the close green turf, with the mountain pansy, the purple primrose, the rock-rose, and the ferns of a calcareous soil (*Cystopteris*, *Asplenium Trichomanes*, *Polypodium calcareum*). To the south are sombre fells covered with heather and long grasses (the Weets, Ryeloaf, Scosthrop Moor, &c.), rising out of a gently-undulating plain of rich meadows and pastures. Brook-sections immediately south of the fault reveal beds of sandstone and shale, with thin limestones, such as are not met with to the north until we get high upon Fountains Fell or Penigent. The Mid Craven Fault diminishes eastward; it has been traced as far as Pateley Bridge. The remaining division, or the South Craven Fault, follows the Aire to Skipton, and appears to be continuous with the faults which traverse the Skibeden valley between Skipton and Bolton. A less important branch may be traced along an east and west line between Airton and Winterburn.

Malham Cove is an escarpment of the limestone 285 feet high. This measurement will give by comparison some notion of the thickness of the Mountain Limestone, which is here about 800 feet. Some 200 feet of the limestone lie buried beneath the foot of the Cove.

Flora of Malham.—Malham has long been classic ground to the botanist, and the following short list of rare species will explain the eagerness with which Ray, Richardson,

* W. H. Dalton, *Proc. W. R. Geol. Soc.* N.S. vol. i. pp. 16—22 (1872).

Williselt, Lawson, and Robinson searched its rocks, and their frequent mention of it in books or letters :—

Thalictrum calcareum, Jord. Gordale.
Trollius europæus,* L. Cove.
Actæa spicata, L.† Cove, Malham Moor.
Thlaspi alpestre, L.‡ Malham Moor and Cove.
Hutchinsia petræa, Br. Awes Scar.
Cochlearia officinalis, L. ; var. *groenlandica*. Gordale, &c.
Draba muralis, L.
Helianthemum canum, Dun.
Geranium sanguineum, L. Cove.
Hippocrepis comosa, L. Cove and Tarn.
Potentilla verna, L. Tarn.
Potentilla alpestris, Hall. Gordale.
Pyrus Aria, Sm. Cove.
Ribes rubrum, var. *petræum*, Sm. Malham Moor.
R. alpinum, L. Gordale.
Galium pusillum, L. Above Gordale.
Hieracium Gibsoni, Backh. Gordale.
Gentiana Amarella, L.
Polemonium cæruleum,§ L. Gordale and Cove.
Orobanche rubra, Sm. Tarn (Dr. Windsor).
Bartsia alpina, L. Gordale, Malham Moor.

Primula farinosa, L.
Armeria maritima, Willd. Stockdale.
Epipactis ovalis, Bab. Gordale.
E. palustris, Sm. Above Gordale.
Gymnadenia conopsea, Br.
Gagea lutea, Ker. Cove.
Carex curta, Good. Tarn.
C. intermedia, Good. Tarn.
C. tertiuscula, Good. Tarn.
C. limosa, L. Tarn.
Sesleria cærulea, Scop. Cove, Gordale.
Hordeum sylvaticum, Huds. Cove.
Polypodium calcareum, Sm.
Polystichum Lonchitis, Roth.
Asplenium viride, Huds.
Lycopodium selaginoides, L.
L. selago, L.
Equisetum hyemale, L. Cove.
Chara vulgaris, L. Tarn and Cove.
C. hispida, L. Tarn.
C. aspera, W. Tarn.

Maritime and Boreal Plants of Craven.—The occurrence among the hills of Craven of certain maritime species, such as Scurvy-grass (*Cochlearia officinalis*), *Silene maritima*, Thrift (*Armeria maritima*), and *Plantago maritima*, suggests questions hardly ripe for solution. The distribution of these species in Yorkshire is here given in detail. Beyond Britain, all are arctic, alpine, and maritime; occurring, that is to say, each in each habitat. The Scurvy-grass is found in Europe, Asia, and N. America; *Silene maritima* in Europe alone; the other two in congenial situations throughout the northern hemisphere. The Thrift extends along the Andes into Chili.

* “And now that I am speaking of local or provincial plants, give me leave to tell you that I think you labour under a mistake in thinking and asserting that few or no plants are peculiar to this or that shire. Be pleased to resolve me where *Calceolus Mariæ* [*Cypripedium calceolus*, L.], *Christophoriana* [*Actæa spicata*, L.], *Lysimachia lutea flore globoso* [*Trollius europæus*, L.], *Pentaphylloides fruticosa* [*Potentilla fruticosa*, L.], *Polygonatum floribus ex singularibus pediculis* [*Convallaria Polygonatum*, L.], *Pyrola folio mucronato serrato* [*Pyrola secunda*, L.], *Pyrola Alsines flore brasiliana* [*Trientalis europæa*, L.], *Ribes alpinus dulcis* [*Ribes alpinum*, L.], *Salix pumila montana folio rotundo* [*Salix herbacea*, L.], *Sedum alpinum Ericoides cæruleum* [*Saxifraga oppositifolia*, L.], *Sideritis arvensis latifolia hirsuta flo. luteo* [*Galeopsis dubia*, Leers.], *Thlaspi foliis Globulariæ* [*Thlaspi alpestre*, L.], *Lunaria vasculo sublongo intorto* [*Draba incana*, L.], and *Valeriana græca* [*Polemonium cæruleum*, L.], grow wild but in your own native county of Yorkshire.”—Ray to Dr. Robinson, 1694. (?) All the plants quoted in this list have since been found elsewhere. The truly local plants of Malham (and of Craven) are *Hieracium Gibsoni*, a species of doubtful value, and the moss *Cinclidium stygium*, which has not been found in Britain except in the bog near Malham Tarn.

† “*Christophoriana*, Ger. [*Actæa spicata*, Linn.] among the shrubs by Malham Cove, Yorkshire.”—Thomas Lawson to Ray, April 9, 1688.

‡ “I am sorry you have had soe much trouble in quest of *Thlaspi Globulariæ folio* [*T. alpestre*, Linn.], which grows upon all the heaps of earth that have been dug out of the old lead mines betwixt Malham and Settle; and very often in the same places is to be met with *Alsine pusilla pulchro flore folio tenuissimo* [*Arenaria verna*, L.]; but, except you know the plants perfectly well, you can scarce know them, except when in flower.”—Richardson to Rauthmell, Sept. 2, 1737.

§ “And as for *Valeriana græca* [*Polemonium cæruleum*, L.], I have found that also in an unquestionable place this last week, both with a white flower, and also a blue one, viz., under Maulam Cove, a place so remarkable that it is one of the wonders of Craven.”—Dr. Martin Lister to Ray, June 4, 1670.

DISTRIBUTION IN YORKSHIRE.

Cochlearia officinalis, L.—Common on the sea-coast; western hills, in many places, descending along the river-banks into the Vale of York.

Silene maritima, With.—Coatham salt-marshes; sandy ground near Redcar; rocks between Saltburn and Huntcliffe; Moughton Fell.

Armeria maritima, Willd.—Middlesborough and Coatham salt-marshes; Whitby; Woodhall lead-mines, near Askrigg, in Wensleydale, and along the stream running from them to the Ure; the Whey Sike in Teesdale; Stockdale, between Settle and Malham (on sandstone), where it was known to grow in the time of John Ray.*

Plantago maritima, L.—Common on the sea-coast. Seamerdale (in Wensleydale); Cronkley Scar, High Force and Winch Bridge (all in Teesdale); roadside between Grassington and Kilnsey, where it was noticed by Curtis in 1782.

It is still a question whether the inland range of these plants, or of some of them, is to be attributed to a preference for soil containing certain saline ingredients, or to that arctic and alpine tendency which is so strongly manifested in their distribution beyond Britain. The first alternative may be supported by such cases as the *Spergularia maritima*, found about the Cheshire salt-mines and the salt-springs of Auvergne and Dauphiné, or *Erodium maritimum*, *Rumex maritimus*, and *Scirpus maritimus*, at the foot of the Malverns. It would be necessary to prove, in order to make out the parallel, that the maritime species under consideration depend upon salt, or some such product of the soil; and further, that such ingredients, present perhaps in lead-washings or mineral veins, are invariably to be found in spots indicated by the presence of these plants.† As yet neither of these lemmas can be proved. On the other supposition—viz., that the Scurvy-grass, Thrift, and the rest, range hither as alpine or arctic plants, not as appropriators of a particular mineral substance—these cases would rank under the class of boreal species, which we proceed next to consider.

It may be well to caution any who propose to attack this problem that one and the same explanation may not be found to fit all the species enumerated; and further, that the question is complicated by obscure difficulties of specific identity—e.g., whether *Armeria maritima* is the same as *A. alpina*. Direct experiment should be tried, in order to ascertain—1st, whether common salt, or any other substance not universally present in the soil, is necessary to the free growth of these species; 2nd, whether any such substance exists in recognisable quantity at the inland stations enumerated above.

An arctic flora occurs on the hills of Craven, as in the Highlands of Scotland, and in many other parts of the world far from the Arctic Circle, but of considerable elevation. The following are among the more typical species:—*Thalictrum alpinum*, L.; *Draba incana*, L.; *Saxifraga oppositifolia*, L.; *S. aizoides*, L.; *Sedum Rhodiola*, DC.; *S. villosum*,

* "Synopsis Stirpium Britannicarum" (1690).

† Mr. J. G. Baker notes ("Life of Charles Kingsley," vol. ii. p. 354) that "there are two other plants, not maritime, that, in the North of England, follow the lead-mines from stream-side to mountain-top—*Thlaspi alpestre* and *Arenaria verna*—the latter most plentiful." The whole letter from which this quotation is made should be read; it contains much good matter, of which I have made use in this place.

L.; *Ribes alpinum*, L.; *Rubus chamaemorus*, L. (cloudberry); *Dryas octopetala*, L.; *Potentilla alpestris*, Hall (*salisburgensis*, Haenke); *Bartsia alpina*, L.; *Salix herbacea*, L.; *Poa alpina*, L.; *Polystichum lonchitis*, Roth. (holly fern); and *Lycopodium selago*, L.* It seems at first sight easy to understand that increased altitude should compensate a comparatively low latitude; but it is to be remembered that Craven, like many other southern habitats of arctic species, is completely isolated from the polar regions by wide spaces of land and sea in which no arctic plants can live. We have thus to explain not merely the southern range of certain arctic species, but their transport across intervening areas of uncongenial climate. Allowance may be made for casual dispersal by the winds and waves, or by migrant birds, but the flora is too numerous to admit of such an explanation as complete. Oceanic islands, re-elevated coral-reefs, volcanic islets, and the population, at once scanty and mixed, which is found upon them after long ages of readiness for stray plants or animals, teach us how impotent is chance migration to explain the transport of a numerous and homogeneous flora. One of the most important generalisations from the facts of distribution may be given thus: Any noteworthy per-centage of species common to two areas means that the physical conditions necessary to the existence of such species extend, or have extended, simultaneously or successively, over the whole intervening space. These considerations lead us to believe that the boreal plants of Craven are remnants of an ancient arctic flora which occupied the British Isles within some part of the glacial period, when we know that the reindeer, glutton, and arctic fox, inhabited the north of England. Subsequent amelioration of the climate has, in this part of Europe, replaced the boreal species by plants native to temperate countries, and the remains of an arctic vegetation, far removed from their kindred, survive only on lofty and exposed hills. More striking instances of the same thing are furnished by the mountains of warm countries. The Himalayas,† the Pangerango mountain in Java,‡ and the mountains of Abyssinia, exhibit an isolated northern flora. The plants of the Alps include species identical with those of Lapland, while the summit of the White Mountains, in New Hampshire, is occupied by the plants of Labrador. On the other hand, the Atlas Mountains and the Peak of Teneriffe, though both rise beyond the limit of vegetation, support no arctic vegetation—a striking and instructive exception. Unless we are prepared to admit that from the beginning everything has been pretty much what it is now, we seem obliged to suppose that the great gaps of distribution were anciently filled up, that arctic cold drove the plants of the far north into low latitudes, extending its influence across the high ground of Central Asia, and even imposing upon Java the plants of a temperate climate. When the temperature rose again, some of the migrants sought congenial climate by returning to the north, while others survived by ascending to considerable elevations.

Minerals and Fossils of Malham.—Near the Cove, on the bridle-road to Settle, are Calamine pits, which have been worked intermittently for many years. The Mountain Limestone of Malham yields many fossils, especially in the upper part. Trilobites occur in

* *Myosotis alpestris*, found on Mickelfell, is to be noted as a similar example.

† Hooker, "Himalayan Journal."

‡ Wallace, "Malay Archipelago," vol. i. p. 118.

tolerable abundance close to the Calamine pits, but a practised eye is needed to discover them. Fossil corals lie in dense masses near the entrance to Gordale, and fragments are built into the walls hereabouts.

Geology of Airedale South of Malham.—South of Malham, the valley of the Aire is occupied by laminated bituminous and earthy Limestones, with partings of shale. No single section exposes any considerable proportion of these South Craven limestones; they are much faulted and contorted, besides being largely obscured by drift, so that their thickness can only be roughly guessed. The upper beds are probably seen in the quarries at and near Skipton, but we cannot certainly distinguish by lithological or palæontological tests the Upper from the Lower Mountain Limestone, and the evidence drawn from the lie of the rocks is incomplete. The South Craven limestones pass largely into shale in Bolland and around Clitheroe. It seems probable that we have in these limestones and shales representatives of part of the Yoredale Rocks of North Yorkshire, and of the upper part of the so-called Lower Scar Limestone of Great Whernside. The synclinals of Rilston Moor, Flasby, and Pinnow Pike are outliers of Kinder Scout Grit and Lower Millstone Grit shales, resting upon the South Craven limestones.

The intermediate limestones are thrown into many folds, of which the longest and most conspicuous have E.—W. axes. The contorted character of the rocks is well seen in the quarries of Thornton-in-Craven, Lothersdale, Skipton, and Draughton. Skipton limestone, known by its dark colour and numerous veins of calcite, can often be recognised in distant parts of Airedale, whither it has been transported by the river or by man. It is much used as road-metal, and as a flux in iron-smelting; it is also burned for lime. The larger veins of calcite mixed with baryte, which sometimes occur near Skipton, are now followed separately, and the spar, which was recently thrown upon the roads, is sold at a good price for the adulteration of white lead.

In the old quarry behind the village of Draughton, solid beds of limestone are bent without fracture into the figure of an inverted W. No better example of contortion could be desired to illustrate the three cardinal facts which every explanation must include—viz., the vast force engaged, its slow operation, and the presence during the crumpling of a great superincumbent mass, in this case of Upper Carboniferous rocks, since removed by denudation.

Ray Gill Quarries.—The quarries of Ray Gill, in Lothersdale, present other points of interest besides the contorted limestone and the thick veins of calcite and baryte. Here was lately (1874) disclosed, by quarrying, a cavity in the rock, which, though apparently surrounded by solid limestone, had formerly communicated with the surface by means of an open fissure. The upper part of the cleft is choked with glacial drift, in which are imbedded pebbles of local, and some few of distant rocks. A space clear of drift has been left, forty to fifty feet from the top, which the gradual removal of the face of the quarry is now fast diminishing (1876). In this space bones of the following animals have been found :—

Elephas antiquus.
Hippotamus amphibius.
Hyæna spelæa.

Rhinoceros leptorhinus.
Bos primigenius.
Bison priscus.

The fauna is apparently of inter-glacial age, and the bones were probably introduced into the fissure either by the ice-sheet itself or by flowing water. From the sealing-up of the cleft by glacial drift we might conclude, if other evidence were not to be had, that the animals enumerated lived in Yorkshire in Pleistocene times, or before the close of the glacial period. The bulk of the remains are preserved in the Leeds Museum, to which they were contributed by Mr. E. G. Spencer and Mr. Tiddeman.

Geology of Airedale South of Skipton.—The succession of the Millstone Grit beds in Airedale has already been noticed. Below Skipton the valley presents few points of special interest beyond those which relate to stratigraphical geology. At Cononley, a vein of galena is worked in the Millstone Grit. Both cheeks are of flags and shale, and it is interesting to notice that here, where the limestone is distant, no organic remains occur in the "dowk" or vein-stuff. Mr. Charles Moore* says:—"I have not failed to detect them, more or less abundantly, except in one instance—in that of the Cononley Mine in the Airedale district." Baryte, witherite and fluor accompany the galena.

At Harden, on the grit edge which overlooks the village from the north, a natural cave has been formed, not, as in the case of the North Craven caves, by the solvent action of water and carbonic acid, but by the partial slipping of a great and irregular block of well-jointed sandstone from the edge of the cliff. The entrance is narrow, and not easily found. It is possible to wriggle for many yards along a tortuous and difficult passage, in which the crevice traverses the open joints, now vertical, now horizontal. After descending a step of about twenty feet, the bed of a subterranean stream is reached, in which are many rounded pebbles of local rocks. The cavern contains no ancient remains, and is interesting solely on account of the mode of its formation.

Above Bingley the valley of the Aire is occupied by beds of roughly stratified gravel and sand, which may be eskers heaped up by a stream debouching upon an ancient lake or arm of the sea. Some three miles lower down, the river takes a sharp turn, and quits the main valley. Instead of cutting through Hirst Wood, where the Midland Railway now passes, it bends sharply back, and after a second abrupt turn, flows through a confined gorge, which opens into the principal valley half a mile lower down. The railway-cutting in Hirst Wood exposes a great thickness of clay and rounded boulders. Putting the local facts together, it appears that the river-course was once nearly straight, but that by glacial deposit (apparently re-arranged by water), the channel became obstructed with drift. The stream was thus deflected, and forced to cut for itself a new course. This it did by channelling out the solid rock, and leaving the much looser obstruction comparatively untouched. South-east of the drift-mound—that is, down stream—we may still distinguish the ancient channel in the low and swampy ground, fringed by Hirst Wood on one side and Nab Wood on the other. It is possible that the damming-up of the Aire below Bingley facilitated the production of the eskers or mounds of rudely stratified drift at Marley.

* "Brit. Assoc. Report," 1869, p. 369.

RIBBLESDALE.

General Lie of the Rocks.—The Ribble, which rises beneath Cam Fell and Blea Moor, was, before the construction of the Settle and Carlisle Railway, rarely traced higher than Horton-in-Ribblesdale, where it flows between Ingleborough on the west and Penigent on the east. Here the Silurian slates which form the geological basis of Craven appear in the stream. They continue to reach the surface over an irregular area, which widens towards Settle, and sends out two expansions—a western round the base of Ingleborough, and an eastern (already traced, see p. 14), which stretches away continuously to Capon Hall, Malham Tarn, and Gordale. The slates occupy all the low ground from Selside to Stainforth, and rise to 1,160 feet above sea-level on Moughton Fell. Along their southern boundary they are cut off by the North Craven Fault.

The Mountain Limestone rests unconformably upon the slates, covering a wide space with its dry and fissured terraces and its white scars. Above the limestone the Yoredale Rocks and Kinder Scout Grit occupy the summits of Ingleborough, Penigent, Coska, and Fountains Fell. Between the North and Mid Craven Faults the limestone comes in at a lower level, and stretches from Ingleton to Wharfedale in a narrow slip, defined along nearly the whole of this distance of twenty miles by slate rocks to the north and Yoredale rocks to the south.

Silurian Rocks.—The Silurian rocks of Yorkshire are divisible into two groups, not very dissimilar lithologically, but unconformable, and containing few common fossils.* The lower series includes the Green Slates and Coniston Limestone—probable equivalents of the Caradoc beds; while the upper consists of the Coniston Flags and Grits (Upper Silurian). The lower series is visible in Chapel-le-dale and in the slate-quarries of Ingleton, at Horton, at Austwick Beck Head, where they lie in a sharp anticlinal running east and west, and around the village of Wharfe, where they are brought up by a parallel anticlinal, cut off on the north by a fault.

The Coniston Limestone is particularly well seen at Douk Gill, near Horton, at Wharfe Mill Dam, and at Wharfe Gill Dyke. An interval of time, during which upheaval and denudation went on, separated the formation of the Lower from that of the Upper Silurian series. This is shown by the fact that the Coniston Flags rest upon different members of the lower series, while the base of the Flags consists in some places of a conglomerate largely made up of fragments of the older beds. The Coniston Flags lie in a great synclinal, intermediate to the two anticlinals above-mentioned. This synclinal crosses Ribblesdale below Horton, and reappears in the adjacent Crummack valley, where the basin, somewhat shallower and more elevated than in Ribblesdale, is readily made out at a little distance. The Coniston Flags are divided by Prof. Hughes into four groups:—

* For many of the facts given in the following description of the Silurian rocks of Ribblesdale and the district I am indebted to an interesting and exact memoir on "The Break between the Upper and Lower Silurian Rocks of the Lake District, as seen between Kirkby Lonsdale and Malham, near Settle" (*Geol. Mag.* 1867, p. 346), by Prof. T. M'K. Hughes, whom I have also to thank for explaining the arrangement of the rocks to me on the ground.

1. A conglomerate containing Lower Silurian pebbles, and resting unconformably upon Lower Silurian beds. (Southwaite, Austwick Beck Head.)
2. Soft, well-cleaved slates. Thickness, probably several hundred feet. (Brackenbottom, Austwick Beck Head, Southwaite.)
3. Tough grits, with subordinate beds of flags. Thickness, about 1,000 feet. (South of Horton, Bargh House, between Crummack and Southwaite.)
4. Flags, with subordinate beds of grit (Coniston Flags proper). Thickness, about 2,000 feet. These slates are well seen in the quarries of Foredale and about Studfold on the opposite side of the valley. Owing to the eastward fall of the synclinal axis, they do not reappear in the Crummack valley.

At the south end of Studfold Low Pasture the Coniston Flags are overlaid by a small patch of tough grits, which reach a thickness of about 1,200 feet on Casterton Fell, and are known in the Lake District as the Coniston Grits. They do not reappear in Craven.

Professor Hughes gives the following lists of fossils. Those printed in small capitals and followed by a note of stratigraphical distribution, have a special bearing upon the geological age of the containing rock :—

CONISTON LIMESTONE.

<i>Halysites catenularia.</i>	<i>Leptæna sericea.</i>
<i>Heliolites.</i>	——— <i>transversalis.</i>
PETRAIA ÆQUISULCATA (Caradoc).	——— sp.
<i>Favosites fibrosus.</i>	<i>Lingula</i> (two species?).
——— (two other species).	ORTHIS ACTONIÆ (Llandeilo, Caradoc, Lower Llandovery).
<i>Encrinites.</i>	——— BIFORATA (Llandeilo, Caradoc, Lower Llandovery).
<i>Cystideans.</i>	<i>Orthis calligramma.</i>
A phyllopod crustacean.	——— <i>elegantula.</i>
<i>Calymene brevicapitata.</i>	ORTHIS FLABELLULUM (Caradoc).
<i>Cheirurus bimucronatus.</i>	——— PORCATA (Caradoc, Llandovery).
CYBELE VERRUCOSA (Caradoc, Lower Llandovery).	——— VESPERTILIO (Llandeilo, Caradoc).
<i>Illænus.</i>	<i>Orthis</i> sp.
<i>Lichas.</i>	<i>Strophomena depressa.</i>
PHACOPS CONOPHTHALMUS (Caradoc).	<i>Murchisonia</i> (?).
<i>Phacops</i> , sp.	<i>Lituites</i> (?).
<i>Remopleurides.</i>	<i>Orthoceras.</i>
ATRYPA MARGINALIS (Caradoc, Lower Llandovery).	
LEPTÆNA QUINQUECOSTATA (Llandeilo, Caradoc).	

All these are Caradoc fossils.

Above the Coniston Limestone, but conformable with it, is seen, at Southwaite and Norber, a series of slates with “ash-like beds” and bands of packed concretions. Here occur—

PETRAIA SUBDUPLICATA, var. <i>crenulata</i> (Caradoc, Llandovery).	ORTHIS BIFORATA (Llandeilo, Caradoc, Lower Llandovery).
<i>Encrinites.</i>	<i>Orthis calligramma.</i>
PHACOPS APICULATUS (?).	——— sp.
——— OBTUSICAUDATUS (?)	<i>Strophomena depressa.</i>
TRINUCLEUS CONCENTRICUS (Caradoc, Llandovery).	STROPHOMENA ALTERNATA (Caradoc).
	<i>Strophomena</i> , sp.
	<i>Orthoceras</i> , &c.

All these are Caradoc fossils.

CONISTON FLAGS.

Favosites fibrosus.

ACTINOCRINUS PULCHER (Wenlock).

Graptolites Ludensis.

———— sp.

PTERINEA TENUISTRIATA (Ludlow). [(Ludlow).

CARDIOLA INTERRUPTA (Upper Llandoverly, Wenlock,

*All these are Upper Silurian.**Lituites giganteus.*

ORTHOCERAS PRIMÆVUM (Wenlock).

———— SUBUNDULATUM (Wenlock).

Orthoceras ventricosum (?).

Worm tracks, &c.

Swallow-holes and Caves.—Near Horton and Selside are many pits in the limestone, known locally as “pots.” Chasms and caves abound in pure calcareous rocks, wherever they are hard and massive. We find them in the Mountain Limestone, not only of the North of England but of Somersetshire, Derbyshire, Belgium, Westphalia, Maine and Anjou, the Pyrenees and the Department of Aude, Virginia, and Kentucky. They occur in the Permian Limestones of Nottingham; in the Oolitic Limestones of Kirkdale, Franconia, Bavaria, and the Jura; in the Neocomian and Cretaceous Limestones of Périgord, Quercy, and Angoumois, Provence and Languedoc, Northern Italy, Sicily, Greece, Dalmatia, Carniola, and Turkey, Asia Minor and Palestine; in the Tertiary Limestones of Montpellier and Paris, and the Departments of Gard and Gironde.*

The flow of water through a well-jointed rock is, in most cases, the primary agent in the excavation of fissures, pot-holes, and caves. Water, unaided, is indeed a feeble wearing agent; but when rapid enough to bear along stones and sand, it can quickly enlarge its passage by the scour. If these simple physical conditions alone were in question, the form and extent of water-passages in Mountain Limestone would still differ from those in sandstone and shale, by reason of the greater tenacity and homogeneity of the rock. Falls of rock would be less frequent, and the stream would choke less readily. But there is another property of limestone far more important in this connection than its compactness. Water containing carbonic acid has the power of dissolving carbonate of lime. Wherever the acidulated water, or its vapour, can reach, the rock is either dissolved in films or etched and fretted away. Fallen blocks do not here, as in the water-passages of argillaceous rocks, crumble to clay or mud, but remain firm and angular until bit by bit they waste and disappear. High above the level of the stream, moisture laden with carbonic acid settles upon the roof of the cavity, and slowly corrodes it.

Evaporation of the water, or the mere escape of its carbonic acid, causes the calcareous matter to be thrown down, and thus a water-cave in limestone rocks is commonly ornamented with stalactites hanging from the roof, or stalagmitic films along the floor and sides.

Thirl Pot lies close to Horton, on the side of Penigent. It is a vertical chasm with an oval opening. The depth is not very great, and the descent can be made with or without ropes, through a narrow lateral cleft. It is said that a vein of galena, which may be seen to traverse the walls of Thirl Pot, furnished the lead for the roof of Horton Church. The stream at the bottom descends rapidly through the rock, and emerges in Douk Gill.

Thund Pot lies in the next field to Thirl Pot. It has a shelving mouth, and descends

* This list is taken, with unimportant alterations, from Professor Boyd Dawkins' “Cave-Hunting,” p. 25.

at least two hundred feet before the stream is reached. This dangerous pit has not been explored fully.

Hellen Pot, on the Limestone plateau of Ingleborough, seems to have arisen by the falling in of part of the roof of a network of subterranean water-courses. One of these, the Long Churn Cavern, may be entered 150 yards north-west of the principal swallow-hole. The passage is not very difficult, and a small stream may be followed along its rough and precipitous descent through clefts, chambers lined with stalactites, water-falls and pools, until it plunges into the vertical pit of Hellen Pot, at about 100 feet from the surface. Other passages, some as yet unexplored owing to the depth of water, some dry, ramify from Long Churn Cavern. The open mouth of Hellen Pot is a fissure 100 feet long by 30 feet wide, grown with trees and ferns. A small rivulet empties itself into the chasm, and falls 198 feet clear. Ledges project from the side, and just below the entrance of the stream from Long Churn Cavern is a great fallen block, 10 feet long, which lies across the gulf. From the foot of the first vertical descent a passage may be followed along the bed of an underground stream. Waterfalls and rapids render the way difficult, but two parties have succeeded in reaching a distance of about 170 feet from the foot of the shaft of Hellen Pot. Here, in the darkness of a lofty chamber, a waterfall, said to be about 40 feet high, precipitates itself into a deep basin. The united streams disappear in a quiet, circling pool, at the end of the chamber, and upwards of 300 feet from the surface.

This formidable cavern was descended by Mr. Birkbeck and Mr. Metcalfe in 1847. The following year baulks of timber were laid across the top, and a much easier descent was made by means of a bucket and windlass. Mr. Birkbeck and eight others formed the exploring party. In 1870, a similar descent was made by Mr. Birkbeck and twelve others, of whom three were ladies.* The timbers still lie across the mouth, as if to invite further attempts.

Hellen Pot well illustrates the first formation and subsequent history of many a limestone cavern. There is the enlarging of fissures, the grinding away of the rock by a sand-bearing stream, the slow decay of the damp roof, and finally, the falling in of the top. "The two actions," says Professor Dawkins, "by which caves are hewn out of the calcareous rock are here seen in operation side by side. Below the level of the stream the rock is seen to be smoothed and polished by the mechanical action of the material swept down by the current. Above the water-level the sides of the cave are honeycombed and eaten into the most fantastic and complex shapes, the resultant surface bearing small points and keen knife-edges of stone that stand out in relief, and mark the less soluble portions of the rock. This is due to the chemical effect of the carbonic acid in the water percolating through the strata. . . . The floor of the pot and the cave was strewn with masses of limestone, rounded by the action of the streams, and the water-channels were smoothed, and grooved, and polished, in a most extraordinary way, by the silt and stones carried along by the current. Some of the layers of limestone were jet-black, and others were of a light fawn-colour, and as the strata were nearly horizontal, the alternation of colours gave a peculiarly

* An account of this descent is given by Professor Boyd Dawkins in his "Cave-Hunting," p. 41. A narrative of the earlier explorations of Hellen Pot is contained in Howson's "Guide to Craven."

striking effect to the walls. Beneath each waterfall was a pool, more or less deep, and here and there in the bed of the stream were holes, drilled in the rock by stones whirled round by the force of the water. High up, out of the present reach of the water, were old channels, which had evidently been water-courses before the pot and cave had been cut down to their present level. In the sides of the pot there are two vertical grooves, reaching very nearly from the top to the bottom, which are unmistakably the work of ancient waterfalls. There was no stalactite [in the further passages], but everywhere the water was wearing away the rock and enlarging the cave." *

Katnot Cave, Brow Gill Cave, Birkwith Cave, Jackdaw Hole, Sel Gill, and a hundred unnamed caverns and swallow-holes, pierce the limestone floors of Ingleborough and Penignt on the Ribblesdale side. The more extensive and famous caves of Clapham and Weathercote lie beyond the limits of Craven.

Victoria Cave, Settle.—The range of Limestone Scars in which the Victoria Cave opens, lies north of the Attermire Rocks, and a mile and a quarter N.E. of Settle. The cave faces S.S.W., about 1,450 feet above the sea, and 900 feet above the Ribble, which is about a mile distant. From the mouth of the cave the eye ranges over an extensive landscape of green pastures, through which the Ribble and Lune wander. At greater elevations are the brown moors of Bolland, and the white rocky terraces of Ingleborough, Moughton, and Penignt. The Lake Hills bound the view northwards, and Pendle Hill to the south.

Here the Victoria Cave was discovered by Mr. Joseph Jackson, of Settle, in 1837. It was explored by him and others in a desultory way, but with many curious results, until, in 1870, a committee of the local gentry, subsequently assisted by the British Association, undertook to dig out the cave systematically.

The floor of the cave when first examined gave abundant proof of habitation by man at different times, some of them very remote. In the superficial or Romano-British layer have been found coins of Trajan (98–117), Tetricus (267–272); Gallienus (260–268); Constantine II. (337–343); Constans (337–350); and three base coins, cast in imitation of the *minimi* of Tetricus. With these were two harp-shaped bronze fibulæ, a split-ring fibula, a brooch of bronze, made by soldering together two circular plates, and stamped with a regular trifoliate, spiral pattern (the so-called Celtic scroll), enamelled fibulæ of late Celtic manufacture, fibulæ plated with silver bracelets, pins, a Roman key, knife-blades, a spear-head, and a scent-box perforated with four holes. There were also pins, studs, buttons, and knife-handles of bone, carved spoon-shaped bone fibulæ, glass beads, stone pot-boilers, hearthstones, black, white, and red Samian pottery. Bones associated with these relics have been identified as belonging to the red deer, roebuck, Celtic short-horn (*Bos longifrons*) sheep or goat, pig, horse, badger, fox, and dog.

Beneath the Romano-British layer, towards the mouth of the cave, lay a thickness of loose fragments of fallen stones, to the amount of five or six feet, imperfectly cemented by stalagmite. Remains of pre-historic antiquity occur beneath this loose talus. Here was found a bone harpoon with double barbs, a sculptured bone bead, and three flint flakes. To the

* "Cave-Hunting," pp. 42, 45.

same (Neolithic) horizon are referred a rude leaf-shaped flint found in 1874, and a small adze of melaphyre ground to a neat cutting-edge. Strong testimony supports the ascription of the adze to the Victoria Cave, but it is perfectly similar in form, size, and material to Polynesian tools, while no strictly comparable implement has been recorded from European soil. Bones of the brown bear, horse, Celtic shorthorn, and red deer have been found in the Neolithic layer.

The Romano-British and Neolithic deposits extended over nearly the whole surface of the middle and the left-hand principal chamber. When they were formed, the right-hand chamber was almost entirely choked up by still more ancient accumulations.

These are divisible into three layers—the Upper Cave-earth, the Laminated Clay, and the Lower Cave-earth. Far within the cave, the laminated clay ceases, and the upper cave-earth lies directly upon the lower. Mr. Tiddeman describes these deposits in the following terms :—

“In their physical aspect, the upper and lower cave-earth have much in common. They both consist of large and small angular blocks of limestone, intermingled with a stiff buff clay, occasional beds of stalagmite, and fallen blocks of stalactite. The limestone and stalactite have undoubtedly fallen from the roof. The stalagmite has formed upon the floor from time to time, when circumstances have been favourable. In the upper bed much of the clay seems to be derived from the laminated clay beneath, worked up and re-deposited by water, or *puddled* by the animals whose bones are found in it ; certainly where bones have occurred in the surface of this clay, it has lost its characteristic finely-bedded structure, and is simply homogeneous. A good deal of this homogeneous clay has probably been washed down through fine crevices in the roof by little runnels during wet weather, although at present certainly all water that drops from the roof seems to be well filtered. In the lower cave-earth, between the blocks of limestone, little chinks have been filled in with laminated clay, which is possibly of the same age, and deposited under identical circumstances, with the great mass of it above—the conditions necessary for this only being a pre-existing chink and a crack leading to it, wide enough to permit water to trickle through it, bearing the finest impalpable mud.” *

The intermediate stratum of laminated clay presents certain difficulties of interpretation. It is of great but irregular thickness (twelve feet in one place), tolerably free from mixture with other deposits, and consists of a multitude of thin films of clay, such as would result from the subsidence of an intermittent, muddy stream. It extends at least 70 feet from the entrance. Mr. Tiddeman offers the explanation of a flow of water derived from the daily melting of a glacier. It will be seen further on that the existence of a sheet of ice at the mouth of the cave may possibly be required by another set of facts. The laminated clay is perhaps due to this cause, but other equally valid interpretations could be framed. Finely-stratified layers are occasionally found in boulder-clay, and this makes for Mr. Tiddeman's view ; but Professor Dawkins points out that they are also being formed at the present time at the bottom of pools in many caves, such as that of Ingleborough. There are no features of the laminated clay which imperatively require the glacier supposition,† and, perhaps, none which refute it. An intermittent, earth-laden flow of water is implied, and there is more than one way of accounting for its former existence.

The bones yielded by the older and the newer cave-earth are extremely numerous.

* *Proc. W. R. Geol. Soc.* N.S. vol. i. pp. 83, 84 (1875).

† Mr. Tiddeman calls attention to the existence of a few glaciated boulders in its upper layers. The Rev. W. H. Crosskey, who has had much experience of similar clays, and has carefully washed some of the laminated clay of the Victoria Cave for organisms, reports that it is in all respects similar to the laminated glacial clays of the West of Scotland, except that it contains no foraminifera.

They may be conveniently studied in the museum of Giggleswick School, where are also preserved the more recent human ornaments and tools disinterred from the Victoria Cave. In the appended table the fauna is enumerated, so as to facilitate the verification of the general statements and inferences which succeed. The supposed characteristic older ("Pleistocene," or "quaternary") animals are marked *. The absence of the cave-lion, *Felis leo*, var. *spelæa*, is noteworthy.

	Victoria Cave, Older Cave Earth.	Victoria Cave, Newer Cave Earth.	Fissure at Lothersdale.	Wortley, nr. Leeds.	Now extinct.	Now extinct in Britain.
Man	?	?				
* <i>Hyæna crocuta</i> , var. <i>spelæa</i> (Cave Hyæna)	×		×			×
<i>Ursus arctos</i> (Brown Bear)	×	×				×
<i>Ursus ferox</i> (Grizzly Bear)	×	×				×
* <i>Ursus spelæus</i> (Cave Bear)	×				×	×
<i>Canis lupus</i> (Wolf)		×				×
<i>Canis vulpes</i> (Fox)	×	×				
<i>Meles taxus</i> (Badger)		×				
* <i>Elephas antiquus</i>	×		×	?	×	×
<i>Equus caballus</i> (Horse)	?	×				
* <i>Rhinoceros leptorhinus</i>	×				×	×
<i>Bison priscus</i>	×		×		×	×
<i>Bos primigenius</i>	×		×	×		
<i>Sus scrofa</i> (Pig)		×				
<i>Cervus elaphus</i> (Red Deer)	×	×				
<i>Cervus megaceros</i> (Irish Elk)		?			×	×
<i>Cervus tarandus</i> (Reindeer)	×	×				×
* <i>Hippopotamus amphibius</i>	×		×	×		×

The presence of man in the lower cave-earth of the Victoria Cave was supposed to be vouched for by a fragmentary fibula, determined as human, after a long and minute investigation, by Professor Busk. This identification is now withdrawn, and Professor Busk states that he "should not himself be inclined to rest or to base the existence of Pre-Glacial Man on a fragment of bone like that, about which it is impossible that some doubt should not exist." *

Mr. Tiddeman, speaking of the species marked * in the table, remarks that—

"There are two very marked species, the hippopotamus and the hyæna, which point to a very warm climate; of the remainder, the elephant and the rhinoceros, of species both extinct, may be considered, from their frequent companionship with the hippopotamus, and, as Prof. Dawkins points out, from their range, to have also lived in warm countries. The rest are all either adaptable to a wide range of climate, or of temperate proclivities. Upon the whole, then, we have an assemblage of species which require, or could live in, a tolerably warm climate. Arctic species are entirely absent. This state of things must have lasted a long time, but higher in the section the bones become more scarce, the more tropical animals are wanting. The bear, the fox, and the ox, are scattered about at rare intervals; eventually these vanish, and about twenty feet above the busy-looking hyæna floor we come upon the base of the laminated clay, interbedded with an occasional layer of stalagmite, but without a trace of any living thing. We work our way up through it, and find near the top of it some well-scratched boulders, and we look out at the cave mouth, and seeing the rubbish left by a vanished glacier, we naturally ask—Do not these represent the coming events which cast their cold shadows before them, and first drove from the district the tropical animals, and then those of greater powers of endurance?" †

* Q. J. Geol. Soc. vol. xxxiii. p. 610 (1877).

† Proc. W. R. Geol. Soc. N.S. vol. i. pp. 88, 89.

Prof. Boyd Dawkins contests this view. He considers that a mixed fauna is universal in British bone-caves, and enumerates the species,

"Some of which are extinct, such as the mammoth, the woolly rhinoceros and Irish elk. Others are now living in temperate climates, such as the horse and bison; others in hot countries, such as the spotted hyæna and the lion; while one, the reindeer, which is very abundant, is now only living in the cold region of the north. This mixed fauna is one which is to be met with universally in the bone-caves of this country, and with one exception, that of Baume in the Jura, in those also of France, Germany, Switzerland, and Belgium.

"In some caves in this country, such as Kirkdale, Victoria, and Raygill, in Yorkshire, and in those of Cefn near St. Asaph, and in those of the Mendip Hills, we find the hippopotamus associated with the remains of the above-mentioned species, while in others we meet with northern forms, such as the lemming, lagomys, arctic fox, and glutton, in like association. In the caves of Auvergne, Professor Lartet detected musk sheep along with the same forms, an arctic animal found in this country in the river strata along with the mixed fauna above-mentioned. The species composing this mixed fauna occur in the caves of Britain in the closest possible relation to each other. In none do we find the southern group of animals in one situation and the northern in another; but they are found mingled together either just as they were left by the hyænas or by palæolithic man, or as they were introduced by a stream, or by the falling in of animals into swallow-holes, as the case may be.

"On this point the experience of Buckland and Falconer is amply confirmed by my own. Nor is the reputed case of the Victoria Cave an exception, in which a southern fauna with hyæna, rhinoceros, and hippopotamus is stated by Mr. Tiddeman to be met with below the horizon of reindeer. While the exploration was under my charge, the reindeer was determined from the stratum in question, in 1872, and published in the British Association Report for that year, which apparently has been overlooked in the succeeding reports. It is not to be seen in the collection from the cave in the Giggleswick Grammar School. The same intimate association of northern and southern forms is observable in a large number of river-strata, as may be seen by my lists published in 1869 (*Quarterly Journal Geological Society*, p. 199)." *

At the mouth of the cave the explorers found it necessary to remove a great thickness of talus or rock-*débris*, which had fallen, bit by bit, from the overhanging cliff. This attained in places a depth of twenty feet. Beneath the talus a line of boulders was unexpectedly struck. The boulders were well scratched, and consisted of large and small fragments of Silurian Grit, Mountain Limestone, Mountain Limestone Conglomerate, and Millstone Grit. They lay in a stratum of no great thickness, dipping away from the entrance, and resting against the edge of the lower cave-earth.

When these boulders had been imperfectly cleared, various opinions were expressed as to the mode of their deposition. Professor Boyd Dawkins † puts the case thus:—

"They may be the constituents of a lateral moraine *in situ*, as Mr. Tiddeman suggests, or they may merely be derived from the waste of boulder-clay which has dropped from a higher level. The latter view seems to me to be most likely to be true, because some of the boulders have been deprived of the clay in which they were imbedded, and are piled on each other with empty space between them, the clay being carried down to a lower level and re-deposited. Their position, however, on the edges of the cave-earth, implies, in any case, that they had been dropped after its accumulation."

We shall see that questions of importance turn upon the exact mode in which the boulders were dropped into their present position. To the suggestion that they were not left where we now find them by the ice-sheet, but have fallen from the cliff subsequently, Mr. Tiddeman replies: ‡—

"1. The boulders lie at the base of all the screes, which are nineteen feet thick, and no other boulders occur throughout that whole thickness.

"2. The cliff immediately above the cave is quite free from boulders for a considerable distance.

"3. The screes (talus) are allowed to be the result of the destruction of the cliff above by atmospheric agencies, and, as they lie above all the boulders, must have fallen subsequently. Even now the boulders lie so close beneath the cliff that it would be barely possible for them to fall from it into their present position. But if we could restore to the cliff all the limestone screes lying above the boulders, such a fall would be quite impossible.

"4. The extent of the glacial deposits now exposed is so great, covering an area of 1,200 square feet or more, that it is impossible that they can be a mere chance accumulation of boulders."

* *Journ. Anthr. Inst.*, Nov. 1877.

† "Cave-Hunting," p. 121.

‡ *Proc. W. R. Geol. Soc. N.S.* vol. i. p. 87 (1875).

The writer can testify to the correctness of these statements, and considers it a fair, though not incontestable inference, that the boulders were brought to the mouth of the cave directly by moving ice. It must be admitted that the hypothesis is tenable, not so much by reason of its own strength, as from the absence of substantial alternatives.

We may infer, from the facts already summarised, that many mammals now extinct existed in Yorkshire during Pleistocene times; that the deposit in which their bones lie was covered up—a stratum containing no trace of life, and possibly of glacial origin (the laminated clay)—while the exposed edges of the ossiferous cave-earth were thickly strewn with travelled, and doubtless ice-borne, boulders. It seems fair to conclude that the fauna of the lower cave-earth of the Victoria Cave is of glacial or pre-glacial age—that, at any rate, it inhabited Yorkshire before the ice-sheet had finally disappeared.

The table on p. 27, when illustrated by a few cognate facts, gives independent evidence in support of these positions. In the river-gravels of England we find all the species represented in the lower cave-earth of the Victoria Cave, and, with these, rude flint implements—indubitable signs of coeval man. But when we examine the surface of the ground in the north of England, the river-gravels, with their bones and palæolithic flint implements, disappear, and we find in their place thick and widespread deposits of till or unstratified boulder-clay. The locality nearest to the barren area in which remains of the old fauna have been found in a river-valley is Wortley, near Leeds, where bones of the hippopotamus, elephant, and urus (*Bos primigenius*) have occurred. The absence of signs of the old fauna over the glacial area is both well ascertained and significant. It leaves us still a choice of conclusions. They are absent, either because they never existed there, or because, having once existed, they have been swept away. In deciding between these alternatives, the Lothersdale fissure (p. 19) and the Victoria Cave demand attention. Here we find well within the glacial area, in the one case a few, in the other many, characteristic species of the old fauna. These two exceptional cases of preservation prove the ancient existence of the Pleistocene fauna within the glacial area, and lead to the conclusion that its total absence in river-beds or surface-deposits immediately to the north of Leeds must be explained by the direct action of the ice-sheet, sweeping clear the open country, and sparing the fragmentary remains only where sealed up within rocky chambers.

But on this question also, it is but just to hear the other side. Professor Dawkins says—

“The distribution also of the mammalia is urged in support of the view that palæolithic man is not of post-glacial age, and therefore either inter- or pre-glacial. There are certain areas in Britain in which the marks of recent glaciation are the freshest, and in which the fauna of the caves and river-beds is conspicuous by its absence. This is taken to prove that originally the animal remains were distributed alike over the mountains of Wales, Scotland, and Cumberland, and the high grounds of the North generally, and that they have been removed from those areas by the extension of the ice. The view which I advanced in 1871 (*Popular Science Review*, and ‘Cave Hunting,’ 1874) still seems to me a better explanation of the facts, that the non-glacial lowlands were inhabited by the animals, *while* the ice covered the glaciated areas, in the second ice, or glacier period.

* * * * *

“The physical changes of the glacial period are so little understood even in such a limited area as Britain, that they are a fertile subject for discussion among geologists. Even if they were thoroughly mastered, it seems to me that they would offer no means of testing the age of palæolithic man in non-glaciated areas, or those in which the majority of the ossiferous caves and river-strata are to be found. The glacial period, further, is not a hard and fast line dividing one fauna from another. The classification by means of ice is one thing, and the classification by means of animals is quite a different thing.”*

* *Journ. Anthr. Inst.*, Nov. 1877.

To sum up so intricate a controversy would be no easy task while some cardinal facts (such as the presence of the reindeer in the older deposits of the cave) are still in question. We must wait for further investigation before making up our minds, and this furnishes an additional plea for adequate public support of the explorations now carried on with diligence and care under Mr. Tiddeman's direction.*

Flora of the Mountain Limestone.—The sharp definition of the calcareous rocks of Settle from the argillaceous or sandy rocks, the great vertical range (from 400 to 2,200 feet above sea-level), and the occurrence of both calcareous and non-calcareous rocks under like conditions of elevation, exposure, temperature, and moisture, render it peculiarly interesting to study here the local distribution of plants. For similar reasons the comparative frequency of certain diseases (phthisis, cancer, goitre) supposed to prevail upon some geological areas with greater intensity than elsewhere, might be investigated more usefully here than in almost any other part of England.

The botanical species which show a marked preference for the Mountain Limestone are—

PHANEROGAMIA.

Thalictrum minus, L.
Actæa spicata, L.
Trollius europæus, L.
Thlaspi alpestre, L.
Draba incana, L.
 muralis, L.
Arabis hirsuta, Br.
Cardamine Impatiens, L.
Hutchinsia petræa, Br.
Reseda Luteola, L.
Helianthemum vulgare, Gärtn.
Viola hirta, L.
 lutea, Huds.
Arenaria verna, L.
Geranium sanguineum, L.
Hippocrepis comosa, L.
Potentilla verna, L.
 alpestris, Hall.
Dryas octopetala, L.
Rubus saxatilis, L.
Rosa Sabini, Woods.
 villosa, L.
Poterium Sanguisorba, L.
Ribes petræum, Sm.
 alpinum, L.
Saxifraga oppositifolia, L.
Silene pratensis, Besser.
Galium sylvestre, Poll.
 montanum, Vill.
 boreale, L.
Scabiosa Columbaria, L.
Hieracium Gibsoni, Backh.
 crocatum, Fries.

Hieracium cæsium, Backh.
 vulgatum, var. *rubescens*, Backh.
 pallidum, Backh.
Crepis succisæfolia, Tausch.
Carlina vulgaris, L.
Carduus nutans, L.
Gentiana Amarella, L.
 campestris, L.
Polemonium cæruleum, L.
Bartsia alpina, L.
Orobanche rubra, Sm.
Origanum vulgare, L.
Primula farinosa, L.
Epipactis ovalis, Bab.
Cypripedium Calceolus, L.
Gymnadenia Conopsea, Br.
Polygonatum officinale, All.
Carex fulva, Good.
Sesleria cærulea, Scop.
Festuca sylvatica, Vill.
Brachypodium pinnatum, Beauv.
Avena pratensis, var. *alpina*, Sm.
Aira cristata, Pers.
Melica nutans, L.

FILICES.

Polypodium calcareum, Sm.
Cystopteris fragilis, Bernh.
Lastrea rigida, Desv.
Polystichum Lonchitis, Sw.
Scolopendrium vulgare, Sm.
Asplenium viride, Huds.

* The most convenient and generally useful notices of the Victoria Cave are to be found in Professor Boyd Dawkins' "Cave-Hunting," and in Mr. Tiddeman's "Work and Problems of the Victoria Cave Exploration," cited above.

CHARACEÆ.

Chara vulgaris, L.
 — *flexilis*, L.
 — *hispida*, L.
 — *aspera*, W.

HEPATICÆ.

Fungermannia incisa, Schrad.
 — *echinata*, Tayl.

MUSCI.

Weissia verticillata, Brid.
Seligeria pusilla, B. & S.
Anacalypta lanceolata, C. Müll.
Trichostomum mutabile, Br.
 — *rigidulum*, Sm.
 — *flexicaule*, C. Müll.
Tortula fallax, Hed. var. *brevifolia*.
 — *tortuosa*, W. & M.
Cinclindotus fontinaloides, Beauv.
Encalypta ciliata, Hed.
 — *rhabdocarpha*, Schwaeg.
 — *streptocarpha*, Hed.
Schistidium apocarpum, Hed.
Orthotrichum cupulatum, Hoff.

Orthotrichum anomalum, Bruch.

— *tenellum*, Bruch.

— *stramineum*, Hornsch.

— *crispum*, Brid.

— *Lyellii*, Hook.

Bryum Zierii, Dicks.

Mnium cuspidatum, Hed.

— *orthorhynchum*, Brid.

— *serratum*, Brid.

Cinclidium stygium, Wahl.

Funaria Mühlenbergii, Schw.

Bartramia calcarea, B. & S.

— *Æderi*, Swartz.

Cylindrothecium Montaguei, Br.

Leskea Sprucei, Br.

— *moniliformis*, Wils.

— *subrufa*, Wils.

Hypnum crassinervium, Tayl.

— *Teesdalei*, Dicks.

— *tenellum*, Dicks.

— *catenulatum*, Brid.

— *delicatulum*, L.

— *rugosum*, Ehr.

— *commutatum*, Hed.

— *molluscum*, Hed.

— *incurvatum*, Schrad.

— *depressum*, Br.

Neckera crispa, Hed.

Many lists of the Lichens of Craven have been drawn up, but until the classification of this class is put upon a better footing than at present, it seems almost useless to give a catalogue of the species of the Mountain Limestone. Lichenologists are slow to accept Schwendener's views as to the nature and life-history of these plants, but until the questions raised by him are fairly answered, we can hardly use or quote the specific names now current.*

Bolland.—In the vale of Hodder an anticlinal axis running north-east brings up the limestone about Whitewell and Slaidburn. Parallel to the main axis are smaller folds, in which lie the contorted limestones of Sykes and Whitendale. Yoredale shales form the slopes which surmount the limestones, while the summits of Croasdale Fell, Bolland Knots, Browsholme Moor, and Birkett Fell, which on every side but the south-west shut in the upper part of the vale of Hodder, are composed of Millstone Grit. The upper part of Bolland, which alone enters Craven, is of less interest to the geologist or naturalist than the Trough of Bolland and the western bend of the Hodder. The panorama from Bolland Knots should, however, be noted as one of the finest views in the deanery.

Craven has been diligently searched for two centuries. The older race of English botanists—John Ray, Thomas Williselt, and Dr. Richardson—loved its woods and fields.

* The distribution of plants in Yorkshire has been thoroughly handled by Mr. J. G. Baker, formerly of Thirsk, now of Kew, whose book on "North Yorkshire," and other less elaborate writings, hold out an excellent example to local naturalists. I am indebted to Mr. Baker for many useful facts, and for others to Dr. Carrington, who formerly explored the botany, and especially the cryptogamic botany, of Craven with much diligence.

Here Martin Lister gathered minerals and fossils, and elaborated notions which, crude as they were, entitle him nevertheless to an honourable place among the founders of geology. In later days Phillips applied the new-discovered principles of stratigraphical geology to the Mountain Limestone of Craven, and earned thereby much of his early fame. Side by side with these honoured names may be ranked others, less familiar to the public ear, but hardly less esteemed among students. In our own day, and down to the present moment, Craven has continued to offer in its fields and caves and rocks a wide and varied area for the collection of natural facts. It seems at times as if all the most significant phenomena had been noted; it is hard to find unbroken ground, and the duller or more desponding are prone to shrink from active research into the easier though less productive path of antiquarian natural history. But we may rest assured that the field is as wide as ever, that its fertility is inexhaustible, and that fresh facts will to the end of time reward the seeing eye and the attentive mind.

POSTSCRIPT.

I HAVE to thank several geological friends for help in the preparation of this chapter. Some of my obligations have been already noticed in their places. Mr. J. R. Dakyns, of the Geological Survey, has furnished additions and corrections. Mr. R. H. Tiddeman, of the Geological Survey, has revised the manuscript, and supplied many details for the map. It will be seen that I have made free use of Mr. Tiddeman's published papers, especially of those which record the results of his zealous, careful, and important work at the Victoria Cave. My colleague, Prof. A. H. Green, has prepared the geological section across Craven, and I have further benefited by his revision of the proofs.

CATALOGUE OF THE RARER PLANTS

GROWING IN CRAVEN, IN THE COUNTY OF YORK.

[Compiled for Dr. Whitaker by SAMUEL HAILSTONE, Esq., of Bradford.]

"These are thy glorious works, Parent of Good,
Almighty!" MILTON.

AUCTORES CITATI.

- Flo. Brit.* Flora Britannica. Auctore Jacobo Edwardo Smith, M.D. Societatis Linnæanæ Præsides, &c. Tom. I. II. III.
Huds. Gulielmi Hudsoni Flora Anglica.
With. Withering's Arrangement of British Plants, 1796, 8vo.
Eng. Bot. English Botany, or Coloured Figures of English Plants, 8vo.
Raii Syn. Joannis Raii Synopsis Methodica Stirpium Britannicarum, 8vo. 1724.
Dill. Historia Muscorum (Joannis Jacobi Dillenii), 4to. 1741.
Ach. Prod. Lichenographiæ Suecicæ Prodrömus, Auctore Erik Achario, M.D. &c. 1798.
Bolt. Fil. Filices Britannicæ, by James Bolton, of Halifax, 2 vols. 4to.

MONANDRIA MONOGYNIA.

- CHARA VULGARIS. *Flo. Brit.* 4.
C. HISPIDA. *Ib.* 5.
Var. C. tomentosa. *Huds.* 398. *With.* 2. nec Linn.
In the brook which runs from Malham Tarn before it falls into the ground.

DIANDRIA MONOGYNIA.

- CIRCÆA LUTETIANA. *Flo. Brit.* 13.
Moist hedges and woods.
VERONICA MONTANA. *Flo. Brit.* 21.
In Ravenroyd Wood, near Bingley.
VERONICA SCUTELLATA. *Flo. Brit.* 21.
In boggy places, upon Rumbald's Moor, near Helwick.
PINGUICULA VULGARIS. *Flo. Brit.* 27. *Eng. Bot.* 70.
Gordale. Near the watering-trough by the road-side at Hawcliffe turnpike.

TRIANDRIA MONOGYNIA.

- SCHÆNUS COMPRESSUS. *Flo. Brit.* 44. *Eng. Bot.* 791.
Plentifully adjoining to the rivulet between Malham Tarn and the Cove.

- SCIRPUS CÆSPITOSUS. *Flo. Brit.* 49.
Upon most of the high moors.
S. LACUSTRIS. *Flo. Brit.* 52.
Eshton and Giggleswick Tarns.
ERIOPHORUM VAGINATUM. *Flo. Brit.* 58.
Frequent upon peat moors.
E. POLYSTACHION. *Flo. Brit.* 59. *Trans. Lin. Soc.* vol. ii. 289.
Near Malham Tarn.
E. ANGUSTIFOLIUM. *Flo. Brit.* 59.
Common upon the moors.

DIGYNIA.

- MILIUM EFFUSUM. *Flo. Brit.* 75.
Bingley Woods.
AIRA CRISTATA. *Flo. Brit.* 83.
Settle Rock. *Mr. Hustler.*
MELICA NUTANS. *Flo. Brit.* 92.
Helks Wood, by Ingleton. Woods about Settle.
SESLERIA CÆRULEA. *Flo. Brit.* 94. *Cynosurus cæruleus.*
Huds. 59.
Upon the rock at Settle. Crevices of the Limestone Rocks at the foot of Ingleborough. *Dr. Stokes.*
Upon the rocks at the Strid, near Bolton.

POA AQUATICA. *Flo. Brit.* 95.

In the Leeds and Liverpool Canal, between Stockbridge and Silsden.

P. SUBCERULEA. *Eng. Bot.* 1004, var. P. Pratensis. *Knapfs. Gram. Brit.* tab. 118. Poa humilis. *Flo. Brit.* 1387.

P. NEMORALIS. *Flo. Brit.* 106.

In the woods about the Strid.

FESTUCA OVINA. *Flo. Brit.* 113. v. Fes. tenuifolia. *Sibth.* 44. *With.* 155.

F. VIVIPARA. *Flo. Brit.* 114. Fes. ovina B. *Spec. plant.* 108. (Var. 4.) *With.* 152.

On Ingleborough, Ryeloaf, &c.

F. BROMOIDES. *Flo. Brit.* 117.

Bellbank Wood, near Bingley.

BROMUS PINNATUS. *Flo. Brit.* 137. *Trans. Lin. Soc.* 4 vol. 301. Festuca pinnata. *With.* 158.

Under the walls of Skipton Castle.

AVENA PRATENSIS. *Flo. Brit.* 141.

About Skipton.

TETRANDRIA MONOGYNIA.

SCABIOSA COLUMBARIA. *Flo. Brit.* 171.

About Skipton.

ASPERULA ODORATA.

Plentifully in the hedges and woods about Bingley.

A. CYNANCHICA. *Flo. Brit.* 172. *Eng. Bot.* 33.

About Malham.

GALIAM SAXATILE. *Flo. Brit.* 175. G. procumbens. *With.* 187.

GALIAM PUSILLUM. *Flo. Brit.* 177. *Eng. Bot.* 74.

In plenty about Malham.

G. BOREALE. *Flo. Brit.* 180. *Eng. Bot.* 105.

Upon the rocks at the Strid.

PLANTAGO MEDIA. *Flo. Brit.* 183.

About Skipton, Thornton, &c.

P. MARITIMA. v. *Huds.* 64.

Mountains near Settle. *Mr. Teesdale.*

TETRAGYNIA.

POTAMOGETON DENSUM. *Flo. Brit.* 194.

Giggleswick Tarn.

PENTANDRIA MONOGYNIA.

ANCHUSA SEMPERVIRENS. *Flo. Brit.* 215. *Eng. Bot.* 45.

By the road-side between Settle and Ingleton. *Mr. Teesdale.*

PRIMULA FARINOSA. *Flo. Brit.* 224. *Eng. Bot.* 6.

Covering whole meadows with a fine pinky colour about Conistone and other parts of Craven. *Mr. Caley, in Withering.*

The British flora cannot boast many more beautiful productions than this elegant Primula, which adorns the rills and wet pastures most abundantly in the romantic neighbourhood of Malham.

MENYANTHES TRIFOLIATA. *Flo. Brit.* 225.

In the bogs upon Rumbald's Moor, near Helwick, in the parish of Bingley.

LYSIMACHIA NEMORUM. *Flo. Brit.* 228. *Eng. Bot.* 527.

In woods.

ANAGALLIS TENELLA. *Flo. Brit.* 230. *Eng. Bot.* 530.

In a bog on the right of the road leading between the Vicarage and Greenhill near Bingley.

CONVOLVULUS SEPIUM. *Flo. Brit.* 233.

Skipton, &c.

POLEMONIUM CÆRULEUM. *Flo. Brit.* 234. *Eng. Bot.* 14.

"Found by Dr. Lister in Carlton Beck, in the falling of it into the river Aire; but more plentifully both with a blue flower and a white one about Malham Cove, a place so remarkable that it is esteemed one of the wonders of Craven. It grows there in a wood on the left hand of the water as you go to the Cove from Malham, plentifully; and also at Cordil, or the Wern, a remarkable Cove, where comes out a great stream of water near the said Malham." *Raii Syn.* 288.

Above the Cascade at Gordale.

CAMPANULA LATIFOLIA. *Flo. Brit.* 236.

Between Clapham and Settle.

JASIONE MONTANA. *Flo. Brit.* 241.

VIOLA HIRTA. *Flo. Brit.* 244. *With.* 260.

Amongst the Limestone Rocks, on the common above Gordale, in going from thence towards the Tarn.

V. PALUSTRIS. *Flo. Brit.* 246.

In Ravenrold Wood, near Bingley, in a boggy place on the left of the footpath.

CHIRONIA CENTAURIUM. *Flo. Brit.* 257. *Eng. Bot.* 417. Gentiana Centaurium. *Spec. Plân.* 332; and *Huds.* 102.

In barren places about Eshton, &c.

EUONYMUS EUROPÆUS. *Flo. Brit.* 262.

Skirethorn Wood.

DIGYNIA.

GENTIANA PNEUMANANTHE. *Flo. Brit.* 285. Gentiana palustris angustifolia. *Raii Syn.* 274.

A quarter of a mile beyond Clapham, in the field going the middle way to Ingleton. *Ray.*

G. AMARELLA. *Flo. Brit.* 287. *Eng. Bot.* 236.

About Gordale, below the waterfall. *Mr. Wood, in Withering.* About Settle, *Mr. Hustler.*

G. CAMPESTRIS. *Flo. Brit.* 288. *Eng. Bot.* 237.

Amongst the high rocks above the waterfall at Gordale. *Mr. Wood, in Withering.*

I have found G. Amarella among these rocks, but not the Campestris. *S. H.*

HYDROCOTYLE VULGARIS. *Flo. Brit.* 290.

In swampy ground upon Rumbald's Moor, and upon Cottingley Moor, in the parish of Bingley.

SANICULA EUROPÆA. *Flo. Brit.* 291.

About Gill, Greenberfield, and in the woods about Bingley.

PEUCEDANUM SILAUS. *Flo. Brit.* 305.

Gargrave.

MEUM ATHAMANTICUM. *Flo. Brit.* 308. Æthusa meum. *Sys. Veg. edit.* 14, 287. *With.* 305.

In the mountainous parts of the West Riding, sparingly. *Teesdale.*

OENANTHE CROCATA. *Flo. Brit.* 319.

On the side of the canal between Silsden and Bingley, and by the turnpike gate at Hawcliffe near Steeton.

SCANDIX ODORATA. *Flo. Brit.* 323.

In the meadows between Morton and Rishforth, certainly a native. *Dr. Richardson.*

Growing very plentifully in the meadows, and upon the sides of the brook near Glusburn, certainly wild.

TETRAGYNIA.

PARNASSIA PALUSTRIS. *Flo. Brit.* 340. *Eng. Bot.* 82.

About Skipton, Settle, &c., in boggy places, and at Gordale.

HEXAGYNIA.

DROSERA ROTUNDIFOLIA. *Flo. Brit.* 346. *Eng. Bot.* 867.

Upon Gilstead Moor, near Bingley.

HEXANDRIA MONOGYNIA.

ALLIUM CARINATUM. *Flo. Brit.* 357.

This I observed on the scars of the mountains near Settle. *Ray.* Among rocks at Conystone and Kilnsey. *Curtis.*

ORNITHOGALUM LUTEUM. *Flo. Brit.* 362. *Eng. Bot.* 21.

Under Malham Cove. *Mr. Wood, in With.*

CONVALLARIA MAJALIS. *Flo. Brit.* 370.

In moist woods in Craven. *Mr. Caley, in With.*

C. POLYGONATUM. *Flo. Brit.* 371.

Fissures of rocks near Wharf, Settle, and Skipton. Helks Wood. *Mr. Teesdale.* Sykes Wood. *Mr. Caley.*

POLYGYNIA.

ALISMA PLANTAGO. *Flo. Brit.* 400.

In the dam belonging to the mill at Bracewell.

HEPTANDRIA MONOGYNIA.

TRIENTALIS EUROPÆA. *Flo. Brit.* 406. *Eng. Bot.* 15.

On Rumbald's Moor, about a mile above Helwick, in a flat boggy place on the left of the road leading to Otley.

Invenit T. Willisel, ad orientalem extremitatem Rumbald's Meer, prope Helwick, in comitatu Eboracensi, loco paludoso inter juncos. *Raii Syn.* 286.

OCTANDRIA MONOGYNIA.

EPILOBIUM ANGUSTIFOLIUM. *Flo. Brit.* 409.

Ingleborough. *Pennant.* Among the rocks above Gordale.

E. ALPINUM. *Flo. Brit.* 419. *With.* 368.

Near Settle. *Mr. Teesdale.*

VACCINIUM VITIS IDÆA. *Flo. Brit.* 415.

Upon Rumbald's Moor, in the parish of Bingley.

V. OXYCOCCOS. *Flo. Brit.* 416.

In boggy places upon Rumbald's Moor, near Helwick, &c.

TRIGYNIA.

POLYGONUM AMPHIBIUM. *Flo. Brit.* 423. *Eng. Bot.* 436.

In the Leeds and Liverpool Canal, near Silsden, and in dams and pools near Skipton.

f

POLYGONUM VIVIPARUM. *Flo. Brit.* 428. *Eng. Bot.* 669.

In a moist spot of ground a little below the Culms near Horton in Craven. *Mr. Bingley, in Eng. Bot.*

TETRAGYNIA.

PARIS QUADRIFOLIA. *Flo. Brit.* 431. *Eng. Bot.* 7.

In the woods about Bingley, and particularly near Rishforth.

ADOXA MOSCHATELLINA. *Flo. Brit.* 432.

Bellbank Wood, near Bingley.

DECANDRIA MONOGYNIA.

PYROLA ROTUNDIFOLIA. *Flo. Brit.* 444. *Eng. Bot.* 213.

Mr. Tenant's Wood, near Kilnsey. *Curtis.* I am apprehensive that this plant has been taken for P. minor, and that this habitat applies to the latter. Vide *Flo. Brit.* 445. *S. H.*

P. MINOR. *Flo. Brit.* 444. *Eng. Bot.* 158.

Near Clapham. *Teesdale and Withering.*

DIGYNIA.

SAXIFRAGA UMBROSA. *Flo. Brit.* 449. *Eng. Bot.* 663.

On a rocky bank near a rivulet half a mile west of Mrs. Foster's house, in Hestleton Gill, betwixt Arncliffe and Horton. *Mr. Bingley, in Eng. Bot.*

Reddins Gill, near Keighley. *Mr. Knowlton.*

S. OPPOSITIFOLIA. *Flo. Brit.* 449. *Eng. Bot. tab.* 9.

Ingleborough.

S. AIZOIDES. *Flo. Brit.* 452. *Eng. Bot. tab.* 39. S autumnalis. *Huds.* 180.

Ingleborough.

S. GRANULATA. *Flo. Brit.* 453.

About Malham Cove plentifully.

S. TRIDACTYLITES. *Flo. Brit.* 454.

Upon the walls and buildings at Barnoldswick, Coats-hall, &c. Common in Craven, but rare in Lancashire. *Mr. Caley, in With.*

S. HYPNOIDES. *Flo. Brit.* 457.

About Gordale and Malham, and plentifully on the rocks at the Tarn.

TRIGYNIA.

STELLARIA NEMORUM. *Flo. Brit.* 473.

In Ravenroyd Wood near Bingley.

ARENARIA VERA. *Flo. Brit.* 481. A. Saxatilis. *Huds. ed.* 1. 168. Var. 3. A. laricifolia. *With.*

On the Malham Road above Settle. *Mr. Hustler.*

Mountains about Settle. *Teesdale. Ray.*

At the Strid above Bolton Park. *S. H.*

About the Ebbing and Flowing Well beyond Giggleswick, in plenty. *Bolt.*

A. LARICIFOLIA. Var. 3. *Flo. Brit.* 482.

About the lead-mines at the bottom of Ingleborough towards Horton and Ribblesdale. *Bolt. MSS.* 1768.

PENTAGYNIA.

SEDUM TELEPHIUM. *Flo. Brit.* 485.

In a small glen on the right of the road as you turn to go over the fields to Gordale from Malham.

S. VILLOSUM. *Flo. Brit.* 488.

On the moist rocks about Ingleborough Hill, as you go from the hill towards Horton in Ribblesdale, in ground where peat is got in great plenty. *Raii Syn.* 270. In et juxta montem Hinklehaw prope Settle. *Dr. Richardson.*

Close by Wethercoat Cave, at the foot of Ingleborough. *Mr. Woodward, in With.*

At Settle. *Mr. Hustler.*

SPERGULA NODOSA. *Flo. Brit.* 503.

Plentifully in the moist ground below Gordale, bogs about Settle. *Curtis, in With.*

Malham Cove. *Mr. Hustler.*

DODECANDRIA MONOGYNIA.

LYTHRUM SALICARIA. *Flo. Brit.* 510.

In the fields adjoining to the river at Steeton, and upon the edges of the canal there.

ICOSANDRIA MONOGYNIA.

PYRUS ARIA. *Flo. Brit.* 534. *Crataegus aria. With.* 458. Grass Wood, and Dib, near Coniston.

SPIRÆA FILIPENDULA. *Flo. Brit.* 535. Near Skipton.

ROSA VILLOSA. *Flo. Brit.* 538.

Grass Wood near Kilnsey. *Curtis.* In the Craven part of Yorkshire. *Mr. Wood, in Withering.*

RUBUS IDÆUS. *Flo. Brit.* 541.

Bingley Woods.

RUBUS SAXATILIS. *Flo. Brit.* 544.

In the north-west part of Yorkshire. *Ray*, 261. Woods about Settle and Ingleton. *Curtis.* In the wood beyond the Strid at Bolton.

R. CHAMÆMORUS. *Flo. Brit.* 545.

Ingleborough and Hinclehaugh near Settle. *Ray.* Sides of the highest mountains about Settle and Ingleton.

POTENTILLA VERNA. *Flo. Brit.* 550.

Giggleswick, near the Ebbing and Flowing Well.

GEUM RIVALE. *Flo. Brit.* 555.

Settle, Ingleton, Gargrave, &c.

DRYAS OCTOPETALA. *Flo. Brit.* 555. *Eng. Bot.* 431.

Arncliffe Clowder, near Kilnsay. *Curtis.* Near Settle. *Dr. Fell.* Stonecliffe in Littondale. *Mr. Wood, in With.*

COMARUM PALUSTRE. *Flo. Brit.* 556.

Giggleswick Tarn. In a bog called Maud's Stable, upon Cottingley Moor, in the parish of Bingley.

POLYANDRIA MONOGYNIA.

ACTÆA SPICATA. *Flo. Brit.* 562.

In dumetis infra Malham Cove juxta murum Aquilonem versus prope rupes, ubi Fraxini juniores crescunt, reperiuntur hujus plantæ nonnullæ. *Dr. Richardson. Raii Syn.* 262. In a wood near Clapham. Upon Ingleborough. *Mr. Woodward.* And in the fissures of the very curious natural pavement of limestone at the foot of it. *Dr. Stokes.*

I found it growing among the limestone rocks in passing over the common from Gordale to Malham Tarn.

CHELIDONIUM MAJUS. *Flo. Brit.* 563.

Bolton Abbey, &c.

CISTUS HELIANTHEMUM. *Flo. Brit.* 575.

Plentiful about Malham, &c.

PENTAGYNIA.

AQUILEGIA VULGARIS. *Flo. Brit.* 578.

Upper part of Girling Trough near Conistone. Kilnsey. *Curtis.*

POLYGYNIA.

THALICTRUM MINUS. *Flo. Brit.* 584.

Plentiful under the waterfall at Gordale. Abundantly at Malham and Settle. *Ray.* Kilnsey. *Curtis.*

TROLLIUS EUROPÆUS. *Flo. Brit.* 597.

Moist woods about Settle. *Curtis.* About Malham Tarn.

DIDYNAMIA GYMNOSPERMIA.

GALEOPSIS VERSICOLOR. *Flo. Brit.* 630. *Eng. Bot.* 667. *G. cannabina. With.* 529.

Amongst corn in the fields about Bingley and Keighley.

G. LADANUM. *Flo. Brit.* 628.

Settle. *Mr. Hustler.*

GALEOBDOLOM LUTEUM. *Flo. Brit.* 631.

In Bellbank Wood, near Bingley.

ORIGANUM VULGARE. *Flo. Brit.* 639.

Skipton.

THYMUS SERPYLLUM. *Flo. Brit.* 640.

Var. serpyllum vulgare *hirsutum. Raii Syn.* 231. Malham Tarn, Skipton, &c.

ANGIOSPERMIA.

SCROPHULARIA AQUATICA. *Flo. Brit.* 663.

In Lord Thanet's Canal at Skipton.

TETRADYNAMIA SILICULOSA.

DRABA INCANA. *Flo. Brit.* 678.

About Settle. *Curtis.*

D. MURALIS. *Flo. Brit.* 679.

Arnbar Scar near Arncliffe, Littondale. *Curtis.* A little below Malham Cove. *Mr. Caley.* On the sides of the mountains in several parts of Craven. *Raii Syn.* On Malham Cove. *Mr. Hustler.*

THLASPI ALPESTRE. *Flo. Brit.* 686.

Pastures about the Ebbing and Flowing Well at Giggleswick. Also in many places of the mountainous pastures between Settle and Malham. *Raii Syn.* Growing with *Arenaria verna*, near Settle. *Curtis.*

COCHLEARIA OFFICINALIS. *Flo. Brit.* 688.

Var. *C. Groenlandica. With.* 573, *nec Linn.* Ingleborough Hill. *Mr. Teesdale.*

C. ARMORACIA. *Flo. Brit.* 690.

Upon the banks of Skipton Beck and in Bolland in Craven. *Raii Syn.*

SILICUOSA.

- CARDAMINE IMPATIENS. *Flo. Brit.* 697.
About Settle. *Mr. Hustler.* Giggleswick Scar.
- CARDAMINE AMARA. *Flo. Brit.* 699.
Crosshills, near Kildwick. *Mr. Hustler.*
- ERYSIMUM PRÆCOX? *Flo. Brit.* 707.
I insert this rare plant upon the authority of my much esteemed, much valued, and ever to be lamented friend William Hustler, Esq., who brought me a specimen from the neighbourhood of Settle, but the precise place I have forgot.
- CHERIANTHUS FRUTICULOSUS. *Flo. Brit.* 709. C. Cheiri.
With. 586.
Bolton Abbey, Skipton Castle, &c.
- TURRITIS HIRSUTA. *Flo. Brit.* 716.
Common about Skipton, Bolton Abbey, &c. Settle.

MONADELPHIA PENTANDRIA.

- ERODIUM MOSCHATUM. *Flo. Brit.* 728. Geranium moschatum. *With.* 609.
Gargrave. *Mr. Hustler.*

DECANDRIA.

- GERANIUM PHÆUM. *Flo. Brit.* 729.
In woods about Settle and Ingleton. *Teesdale.* About Clapham. *With.* Beckfoot Lane, near Bingley.
- G. SYLVATICUM. *Flo. Brit.* 731.
About Settle and Ingleton. *Teesdale.* Plentifully in the woods about Bolton Abbey.
- G. LUCIDUM. *Flo. Brit.* 733.
- G. PYRENAICUM. *Flo. Brit.* 735.
On the bank of the river Aire between Bingley and Keighley. *Huds.* I have not been able to find this plant in this place.
- G. SANGUINEUM. *Flo. Brit.* 738.
At Gordale.

DIADELPHIA HEXANDRIA.

- FUMARIA CLAVICULATA. *Flo. Brit.* 752.
Bingley Woods and Hawcliffe Wood near Steeton.

DECANDRIA.

- GENISTA ANGLICA. *Flo. Brit.* 756.
Upon Rumbald's Moor above Morton.
- ANTHYLLIS VULNERARIA. *Flo. Brit.* 759.
In Craven. *Mr. Caley.* Malham.
- VICIA SYLVATICA. *Flo. Brit.* 768.
Malham. *Woodward, in Withering.*
- HIPPOCREPIS COMOSA. *Flo. Brit.* 777.
Limestone rocks about Malham, Settle, Giggleswick, Kilnsay, and Wharf.

POLYADELPHIA POLYANDRIA.

- HYPERICUM MONTANUM. *Flo. Brit.* 803.
Near Ingleton.
- H. HIRSUTUM. *Flo. Brit.* 804.
At the foot of Ingleborough, near to Hirtle Pot, and in many other places in Craven.

SYNGENESIA POLYGAMIA EQUALIS.

- TRAGOPOGON PRATENSIS. *Flo. Brit.* 812.
About Settle, Giggleswick, &c.
- PRENANTHES MURALIS. *Flo. Brit.* 821.
About Bingley. In the Springs, Skipton, and about Malham.
- HIERACIUM MURORUM. *Flo. Brit.* 830.
Bolton Abbey.
Var. B. Hieracium macrocaulon hirsutum folio rotundiore. *Raii Syn.* 169.
Gordil. *Dr. Richardson.*
- H. PALUDOSUM. *Flo. Brit.* 831.
Ravenroyd Wood, near Bingley.
In pratis humidis et juxta rivulos Craveniæ montosos abundat. *D. Richardson, in Syn. Raii,* 166.
- H. VILLOSUM. *Flo. Brit.* 833.
Near Meer Gill, at the foot of Ingleborough.
- HYPOCHÆRIS MACULATA. *Flo. Brit.* 840.
Near Ottermine Cave. Settle. Malham Cove. *Eng. Bot.* 225.
- SERRATULA TINCTORIA. *Flo. Brit.* 845.
Malham Cove.
- CARDUUS HETEROPHYLLUS. *Flo. Brit.* 853. C. helenioides. *With.* 702.
Coppice near Giggleswick, in Skirrith Wood, and in the pastures about Bordley, near Malham.
- CARLINA VULGARIS. *Flo. Brit.* 857.
Near Clapham, Giggleswick, &c.

POLYGAMIA SUPERFLUA.

- GNAPHALIUM DIOICUM. *Flo. Brit.* 869.
Ingleborough, Gilstead Moor, near Bingley.
- ERIGERON ACRE. *Flo. Brit.* 877.
Bingley Locks.
- TUSSILAGO HYBRIDA. *Flo. Brit.* 879.
Near the River Wharf between Ilkley and Skipton.
- SENECIO SARACENICUS. *Flo. Brit.* 887.
About Clapham and Ingleton. *Huds.*
- S. TENUIFOLIUS. *Flo. Brit.* 884.
Gargrave.
- SOLIDAGO VIRGAUREA. *Flo. Brit.* 889.
γ. S. cambrica. *With.* 728.
On the rocky precipice on the summit of Ingleborough to the north-west. *Mr. Woodward, in Withering.*

GYNANDRIA DIANDRIA.

- SATYRIUM ALBIDUM. *Flo. Brit.* 929.
Moist meadows about Malham. *Ray.*
- OPHRYS CORDATA. *Flo. Brit.* 933.
On Ingleborough. On Rumbald's Moor near Helwick.
- O. MUSCIFERA. *Flo. Brit.* 937.
Near Settle. *Mr. Hustler.*
- CYPRIPEDIUM CALCEOLUS. *Flo. Brit.* 941.
About Arncliffe, Kilnsay, Litton, and Kettlewell. In Helks Wood by Ingleborough. *Raii Syn.* But I believe it is now nearly eradicated there by the rapacity of collectors.
- SERAPIAS LATIFOLIA. *Flo. Brit.* 942.
B. helleborine altera atro rubente flore. *Raii Syn.* 383.
On the sides of mountains about Malham and Settle.

- S. ENSIFOLIA. *Flo. Brit.* 945.
Woods at Settle and Ingleton. Helks Wood.
S. RUBRA. *Flo. Brit.* 946.
About Clapham and Ingleton. *Huds.*

MONOECIA TRIANDRIA.

- CAREX DIOICA. *Flo. Brit.* 963.
Rumbald's Moor near Helwick.
C. CURTA. *Flo. Brit.* 967. C. brizoides. *Huds.*
Plentiful on Rumbald's Moor near Helwick.
C. TERETIUSCULA. *Flo. Brit.* 977.
Abundant in Salterforth Moss.
C. DISTANS. *Flo. Brit.* 992.
Giggleswick Tarn. *Curtis.*
C. VESICARIA. *Flo. Brit.* 1005.
Salterforth Moss.
C. AMPULLACEA. *Flo. Brit.* 1006.
Giggleswick Tarn. Rumbald's Moor, near Helwick.

POLYANDRIA.

- POTERIUM SANGUISORBA. *Flo. Brit.* 1025.
Plentiful about Skipton, Thornton, &c.

DIOECIA DIANDRIA.

- SALIX HELIX. *Flo. Brit.* 1040. S. monandra. *With.* 45.
About Thornton, Broughton, and by the canal side
between Skipton and the latter place.
S. TRIANDRA. *Flo. Brit.* 1044.
S. AMYGDALINA. *Flo. Brit.* 1045.
S. PENTANDRA. *Flo. Brit.* 1046.
S. MYRSINITES. *Flo. Brit.* 1054.
On the slope of a high hill between Kilnsay and Arncliffe. *Curtis.*
S. HERBACEA. *Flo. Brit.* 1056.
Ingleborough. *Pennant, Teesdale.*
S. RETICULATA. *Flo. Brit.* 1057.
On the rocks on the uppermost part of Ingleborough,
on the north side, and on Whernside over against
Ingleborough on the other side the subterraneous
river. *Ray.*

OCTANDRIA.

- RHODIOLA ROSEA. *Flo. Brit.* 1082.
On rock on the summit of Ingleborough to the north-
west. *Mr. Woodward.*

MONADELPHIA.

- TAXUS BACCATA. *Flo. Brit.* 1086.
In a truly wild state, growing out of the clefts of the
rocks on Giggleswick Scar and Gordale.

CRYPTOGAMIA. FILICES.

- EQUISETUM HYEMALE. *Flo. Brit.* 1105.
Skipton and other parts of Craven. *With.*
OSMUNDA LUNARIA. *Flo. Brit.* 1107.
Near Settle, Meer Bank by Sykes Wood, in Ingleton.
O. REGALIS. *Flo. Brit.* 1108.
Near Keighley.

- LYCOPODIUM CLAVATUM. *Flo. Brit.* 1108.
Plentiful upon Rumbald's Moor.
L. SELAGINOIDES. *Flo. Brit.* 1109.
Upon the Moor before you come to the Tarn from Malham in abundance.
L. SELAGO. *Flo. Brit.* 1111.
Near the top of Ingleborough.
L. ALPINUM. *Flo. Brit.* 1112.
Near the top of Ingleborough and other high hills in
that part of the county. Upon Rumbald's Moor.
POLYPODIUM VULGARE. *Flo. Brit.* 1113.
γ. P. vulgare lobis proliferis. *Bolt. Fil. t. 2. f. 5. b.*
In a wood near Bingley. *Dr. Alexander.*
P. PHEGopteris. *Flo. Brit.* 1116.
In the woods about the Strid, near Bolton.
P. DRYopteris. *Flo. Brit.* 1116.
Bingley Woods, and particularly in those south of St.
Ives.
P. CALCAREUM. *Flo. Brit.* 1117. P. dryopteris. Var.
With. 781. *Bolt. Fil.* 53. tab. 1.
White Scars near Ingleton.
ASPIDIUM LONCHITIS. *Flo. Brit.* 1118. Polypodium lonchitis. *With.* 773.
Near Bingley. *Huds, edit. 1.* but I believe the Polypodium aculeatum has been taken for this plant, and that Hudson's habitat is an error.
A. ACULEATUM. *Flo. Brit.* 1122. Polypodium aculeatum. *With.* 777, and *Huds.* 459.
Plentiful in Bellbank Wood and the other woods about Bingley.
A. DILATATUM. *Flo. Brit.* 1125. Polyp. cristatum. *With.* 778.
Bingley, Keighley, &c.
ASPLENIUM TRICHOMANES. *Flo. Brit.* 1126.
Skipton Castle.
B. trichomanes foliis eleganter incisis. *Dill. in Raii Syn.* 120.
Ingleborough Hill.
A. VIRIDE. *Flo. Brit.* 1127.
On Ingleborough. Plentiful in the crevices of the limestone rocks about Malham. On walls and rocks about Settle.
Var. B. A. Trichomanes ramosum. *Bolt. Fil.* 25. tab. 2. fig. 3. *Raii Syn.* 119.
On Ingleborough and on limestone rocks in the neighbourhood of Settle and Ingleton.
A. SEPTENTRIONALE. *Flo. Brit.* 1129. Acrostichum septentrionale. *With.* 764.
On Ingleborough.
A. LANCEOLATUM. *Flo. Brit.* 1132.
On a wall in the village of Wharf. *Bolt. Fil.* 31.
Bolton must have made a mistake in referring to the village of Wharf, as there is no such place: what village he meant I cannot even guess.
SCOLOPENDRIUM VULGARE. *Flo. Brit.* 1133. Asplenium scolopendrium. *With.* 766.
Plentiful in Bellbank Wood, and at the foot of the wall as you enter Skipton Castle.
S. CETERACH. *Flo. Brit.* 1134. Asp. Ceterach. *With.* 766.
Rocks about the Tarn at Malham, where it was observed by Ray.
PTERIS CRISPA. *Flo. Brit.* 1137. Osmunda crispa. *Huds.* 450.
Ingleborough.

CYATHEA FRAGILIS. *Flo. Brit.* 1139. Polypodium fragile. *With.* 779.

Malham Cove, Gordale, &c.

Var. B. Polypodium rhœticum. *With.* 780. Gordale.

HYMENOPHYLLUM TUNBRIDGENSE. *Flo. Brit.* 1141. Trichomanes Tunbridgense. *With.* 781.

On the rock called Foal Foot on Ingleborough Hill. Var. B. Trichomanes pyxidiferum. *Bolt. Fil.* 56. tab. 30.

Bellbank Wood, near Bingley, at the head of a remarkable spring. *Ray*. In a little dark cavern under a dripping rock in the same wood. *Bolt*.

Mr. Teesdale also found this rare plant in September, 1782, in the same place as mentioned by *Ray*, but it is not now to be found, and I suspect has been extirpated by the rapacity of those who do not deserve the name of botanists.

CRYPT. MUSCI.

ANDRÆA ALPINA. *Flo. Brit.* 1179. Jungermannia alpina. *With.* 882. *Dill.* 506. t. 73. f. 39.

Ingleborough.

GRIMMIA APOCARPA. *Flo. Brit.* 1200. Bryum apocarpum. *With.* 809.

On trunks of trees and rocks.

DICRANUM SCOPARIUM. *Flo. Brit.* 1201. Mnium scoparium. *With.* 799.

In woods.

D. GLAUCUM. *Flo. Brit.* 1216. Mnium glaucum. *With.* 801.

Bellbank Wood ; but I never detected it in fruit.

D. ADIANTOIDES. *Flo. Brit.* 1234. Hypnum adiantoides. *With.* 844.

Springs and wet woods.

TORTULA RIGIDA. *Flo. Brit.* 1249. Bryum rigidum. *With.* 813.

On Ingleborough.

NECKERA CRISPA. *Flo. Brit.* 1273. Hypnum crispum. *With.* 847. *Eng. Bot.* 617.

On rocks and trunks of trees in the woods about the Strid.

HYPNUM UNDULATUM. *Flo. Brit.* 1294. *Eng. Bot.* 1181. In Bingley Woods. Dr. Smith in "English Botany" observes that it rarely produces fructifications. I cannot say I have found the fruit so rare.

HYPNUM PROLIFERUM. *Flo. Brit.* 1297. *With.* 853. Plentiful in Bellbank Wood.

H. MOLLUSCUM. *Flo. Brit.* 1335. *Eng. Bot.* 1327. H. crista-castrensis. *With.* 854.

Upon the rocks about Gordale.

FONTINALIS SQUAMOSA. *Flo. Brit.* 1337. *With.* 788.

In the brook which runs from the Tarn to the Cove at Malham. *Mr. Mellor*.

BARTRAMIA POMIFORMIS. *Flo. Brit.* 1340. Bryum pomiforme. *With.* 822.

Woods and fissures of rocks.

B. FONTANA. *Flo. Brit.* 1342. Mnium fontanum. *With.* 799.

Bogs and wet places.

BRYUM HORNUM. *Flo. Brit.* 1360. Mnium hornum. *With.* 804.

In shady woods.

POLYTRICHUM COMMUNE. *Flo. Brit.* 1372.

Bogs, &c.

P. ATTENUATUM. *Flo. Brit.* 1373. *Eng. Bot.* 1198.

In turfy bogs.

CRYPT. HEPATICÆ.

JUNGERMANNIA SINUATA. *Dill.* 74. *With.* 869.

Very plentiful at the head of Elm Cragg Well, in Bell Bank, near Bingley.

This is one of those proliferous plants which seldom form fructifications ; and Mr. Wood, in *Withering*, suspects the fructification of this plant had never been found in England ; but in April, 1801, I was so fortunate as to detect a plant in fruit in this place.

J. PINGUIS. *Dill.* 74. *Eng. Bot.* 185.

Bell Bank, near Bingley.

J. ASPLENOIDES. *Dill.* 69. 5. 6. *With.* 870.

Bell Bank. Springs behind Skipton Castle.

J. VITICULOSA. *Dill.* 69. 7. *With.* 873.

Malham Cove.

J. BIDENTATA. *Dill.* 70. 11. *With.* 871.

Bingley Woods.

J. NEMOROSA. *Dill.* 71. *With.* 875.

Bingley Woods.

MARCHANTIA POLYMORPHA. *With.* 884.

Bingley Locks.

TARGIONIA HYPOPHYLLA. *Eng. Bot.* 287. *With.* 883.

Near Keighley. *Mr. Knowlton*.

CRYPT. ALGÆ.

LEPRARIA ANTIQUITATIS. Lichen antiquitatis. *Ach. Prod.* 5. *With.* vol. 4. p. 3.

Upon walls and limestone rocks about Malham.

L. FLAVA. *Eng. Bot.* 1350. Lichen flavus. *Ach. Prod.* 6.

Upon trunks of trees.

LEPRARIA ALBA. *Eng. Bot.* 1349. Lichen albus. *Ach. Prod.* 7.

Rocks, trees, mosses, &c. Gordale.

VERRUCARIA.

LICHEN PERTUSUS. *Ach. Prod.* 17. *With.* vol. 4. 15.

On the bark of trees and upon stones.

L. HYMENIUS. *Ach. Prod.* 80.

On a young ash-tree in the springs behind Skipton Castle.

OPEGRAPHA.

L. VULGATUS. *Ach. Prod.* 21. L. rugosus. *With.* 4.

Bark of trees.

L. SCRIPTUS. *Ach. Prod.* 25.

Bark of trees.

VARIOLARIA.

L. FAGINEUS. *Ach. Prod.* 27.

Trunks of trees, and particularly the beech.

URCEOLARIA.

L. HOFFMANNI. *Ach. Prod.* 31. L. rupicola. *With.* 13.

Walls about Skipton Castle.

- L. SCRUPOSUS. *Ach. Prod.* 32.
On walls and stones.
- L. CINERIUS. *Ach. Prod.* 32. *Eng. Bot.* 820.
Walls beyond Skipton Castle.
- L. GEOGRAPHICUS. *Ach. Prod.* 33.
On rocks.
- L. EXANTHEMATICUS. *Ach. Prod.* 35. *Act. Lin. Soc. tom.*
1. tab. 4. fig. 1. Eng. Bot. 1184.
This rare lichen I found upon the limestone rocks
passing from Gordale to Malham Tarn.

PATELLARIA.

- L. PARELLUS. *Ach. Prod.* 35. *With.* 17.
Rocks, walls, and stones.
- L. TARTAREUS. *Ach. Prod.* 37.
Plentiful upon rocks and walls about Bingley.
- L. CERINUS. *Ach. Prod.* 40. *With.* 24. *Eng. Bot.* 627.
On the trunks of trees, Bingley Woods.
- L. AURANTIACUS. *Ach. Prod.* 44. L. flavorubescens.
With. 15.
On the bark of trees and upon stones about Skipton.
- L. HÆMATOMMA. *Ach. Prod.* 45. *Eng. Bot.* 486.
Var. L. coccineus. *Eng. Bot.* 223.
Upon rocks in Holden Wood, near Silsden.
- L. DISPERSUS. *Ach. Prod.* 49.
Limestone walls.
- LICHEN VERNALIS. *Ach. Prod.* 51.
Bark of trees.
- L. ULMI. *Ach. Prod.* 54. L. marmoreus. *Eng. Bot.* 739.
Upon rocks near Gennetts Cave, at Malham.
- L. SULPHUREUS. *Ach. Prod.* 58. *Eng. Bot.* 1186.
Upon walls about Malham.
- L. CALCARIUS. *Ach. Prod.* 60.
Limestone walls about Gargrave, Eshton, Airton, &c.
- L. LAPICIDA. *Ach. Prod.* 61. L. concentricus. *Trans.*
Lin. Soc. vol. 2. Eng. Bot. 206.
Walls about Broughton.
- L. PARASEMUS. *Ach. Prod.* 64.
Upon the trunks of trees in the springs behind Skipton
Castle.
- L. SANGUINARIUS. *Ach. Prod.* 65.
Upon stones.
- L. SILACEUS. *Ach. Prod.* 66. *Eng. Bot.* 1118.
Crinah Bottom, Ingleborough.
- L. TEPHROMELAS. *Ach. Prod.* 67. L. ater. *With.* 18.
Eng. Bot. 949.
Walls about Malham, &c.
- L. IMMERSUS. *Ach. Prod.* 70. *Eng. Bot.* 193.
Rocks, walls, and stones, about Malham.
- L. QUERNEUS. *Eng. Bot.* 485.
Upon oaks and other trees in Holden Wood.
- L. CALVUS. *Ach. Prod.* 72. *Eng. Bot.* 948.
Rocks at Malham and Ingleborough.

BCEOMYCES.

- L. ERICETORUM. *Ach. Prod.* 91. *Eng. Bot.* 372.
On turfy heaths.
- L. BYSSOIDES. *Ach. Prod.* 82. *Eng. Bot.* 373.
On rotten wood, stones, heaths, &c. Plentiful in Beck-
foot Lane, near Bingley.

PSOROMA.

- L. NIGER. *Ach. Prod.* 92.
Upon limestone walls about Malham.
- L. CANDELARIUS. *Ach. Prod.* 92.
Stones, walls, and trunks of trees.
- L. VESICULARIS. *Ach. Prod.* 94. L. cœruleo-nigricans.
Eng. Bot. 1139.
Gordale.
- L. CRASSUS. *Ach. Prod.* 97. *Huds.* 530. L. cartilagineus.
With. 29.
About Malham.

PLACODIUM.

- LICHEN SYMPAGEUS? *Ach. Prod.* 105. L. flavicans?
With. L. murorum? *Ach. Prod.* 101.
Limestone walls about Bank Newton, &c.

IMBRICARIA.

- L. INCURVUS. *Ach. Prod.* 107. *Eng. Bot.* 1375. L. multi-
fidus. *Dicks. and With.*
Malham Tarn, upon the rails by the canal side at
Broughton.
- L. STELLARIS. *Ach. Prod.* 111. *With.* 31.
Bark of trees.
- L. AIPOLIUS. *Ach. Prod.* 112.
Trunks of old ash-trees, &c.
- L. PULVERULENTUS. *Ach. Prod.* 112. Var. 2d. L. stellaris.
With. 31.
On sycamore, lime, and willow-trees.
- L. OMPHALODES. *Ach. Prod.* 114. *With.* 34. *Eng. Bot.*
604.
Rocks and stones.
- L. SAXATILIS. *Ach. Prod.* 115. *Eng. Bot.* 603.
Rocks and stones. Holden Wood.
- L. PHYSODES. *Ach. Prod.* 115. *Eng. Bot.* 126.
Bark of trees.
- L. CAPERATUS. *Ach. Prod.* 119. *Eng. Bot.* 654.
On stones, rocks, trees, pales, &c.
- L. PARIETINUS. *Ach. Prod.* 121.
Common on walls, stones, houses, and trees.
- L. OLIVACEUS. *Ach. Prod.* 121.
On the bark of trees.

COLLEMA.

- L. MARGINALIS. *Ach. Prod.* 127. *With.* 34.
On walls near Settle.
- L. HYDATERPUS. *Ach. Prod.* 129. L. fluviatilis. *With.*
and Huds.
On stones in the river which comes from under Malham
Cove.
- L. FASCICULARIS. *Ach. Prod.* 129. *Eng. Bot.* 1162.
On walls about Malham.
- L. LACERUS. *Ach. Prod.* 133. L. tremelloides. *With.* 72.
On the ground and upon walls mixed with mosses about
Skipton, Malham, and most parts of Craven.

ENDOCARPON.

- L. MINIATUS. *Ach. Prod.* 141. *With.* 66. *Eng. Bot.* 593.
Upon rocks in a deep glen on the right hand as you
pass to Gordale from Malham.

- LICHEN COMPLICATUS. *Ach. Prod.* 142. L. miniatus. var.
2. of Lightfoot.
Upon stones in the river under Malham Cove.

LOBARIA.

- L. PULMONARIUS. *Ach. Prod.* 152. *With.* 54. *Eng. Bot.*
572.
Upon the trunks of trees in the woods about the Strid,
near Bolton.
L. PERLATUS. *Ach. Prod.* 153.
Upon the trunks of trees.

PELTIDEA.

- L. HORIZONTALIS. *Ach. Prod.* 160.
Bingley and Steeton Woods.
L. CANINUS. *Ach. Prod.* 160.
In moist shady places upon the ground.
L. APTHOSUS. *Ach. Prod.* 161. *With.* 70.
Ingleborough Hill and other places.
L. POLYDACTYLUS. *Ach. Prod.* 162. *With.* 69.
Rumbald's Moor near Helwick. *Richardson and Dil-*
lenius.
L. SACCATUS. *Ach. Prod.* 165. *With.* 67.
About the mouth of Yordas Cave in Ingleborough. *Dr.*
Smith. Gordale.

PLATISMA.

- L. GLAUCUS. *Ach. Prod.* 167.
Beckfoot Lane, near Bingley.

PHYSCIA.

- L. ISLANDICUS. *Ach. Prod.* 170. *With.* 54.
Ingleborough.
L. TENELLUS. *Ach. Prod.* 172. *With.* 56.
On the bark of trees and upon stones.
L. CILIARIS. *Ach. Prod.* 173. *With.* 55.
On trees and stones.
L. FURFURACEUS. *Ach. Prod.* 173.
Stones and trees about Skipton and various other
places.
L. PRUNASTRI. *Ach. Prod.* 174.
Trees.
L. FRAXINEUS. *Ach. Prod.* 175.
Upon oak and ash trees.

- LICHEN FASTIGIATUS. *Ach. Prod.* 175.
L. CALICARIS. *Ach. Prod.* 176.
L. FARINACEUS. *Ach. Prod.* 177.
Upon trees.

SCYPHOPHORUS.

- L. ALCICORNIS. *Ach. Prod.* 184. *Eng. Bot.* 1392. L. folia-
ceus. *With.*
Gordale.
L. PYXIDATUS. *Ach. Prod.* 186.
L. COCIFERUS. *Ach. Prod.* 187.
L. DEFORMIS. *Ach. Prod.* 189.
In shady places upon the earth, among moss, &c.

CLADONIA.

- L. UNCIALIS. *Ach. Prod.* 201.
L. RANGIFERINUS. *Ach. Prod.* 202.
Heaths, woods, &c.
L. SPINOSUS. *Ach. Prod.* 205.
Ravenroyd Wood, near Bingley.

SPHAEROPHORUS.

- L. GLOBIFERUS. *Ach. Prod.* 210.
Rocks and stones.
L. FRAGILIS. *Ach. Prod.* 211. *Eng. Bot.* 114.
Rocks in the woods near St. Ives in the parish of
Bingley; and, though it is observed in *Eng. Bot.* to
be very rarely found in fructification, I have very
frequently observed it in that state even in the driest
seasons.

SETARIA.

- L. JUBATUS. *Ach. Prod.* 219.
Rocks and trees in Bingley Woods and Beckfoot
Lane.
L. CHALYBEIFORMIS. *Ach. Prod.* 220.
Rocks in woods near St. Ives.

USNEA.

- L. FLORIDUS. *Ach. Prod.* 224.
L. hirta. *With. Huds.*
Upon oak, beech, elm, &c. in Bingley Woods.

OBSERVATION.

- EPIMEDIUM ALPINUM, *Eng. Bot.* 438, is said by *Dr. Richardson*, in *Blackstone* 19, to grow in Bingley Woods. I
believe the Doctor was imposed upon, for it certainly is not now to be found there, nor do I believe it to be indigenous
to this country.

CATALOGUE OF MINERALS

FOUND IN CRAVEN, BY W. E. SHEFFIELD, ESQ.

COPPER, &c., ORE OF.

COPPER PYRITES. Copper combined with Iron and sulphur.

MARTIAL PYRITES. Sulphur combined with Iron, with Baroselenite Foliated and Crystallised, found in a mine at Beggarmans, to the north-west of Buckden.

LEAD, ORES OF.

GALENA. Lead combined with Sulphur, the common blue Lead Ore.

LEAD mineralised by Oxygen and Carbonic Acid, the White Lead Ore. Crystallised and compact.

There are many mines in this part of Yorkshire which produce the above varieties of Lead Ore in considerable quantities ; the Liberties of Buckden, Starbottom, Kettlewell, Coniston, Grassington, Hebden, &c. &c., but the White Lead Ore has been raised in greatest quantities in the Liberties of Buckden and Grassington.

GREEN LEAD ORE, Phosphorated Lead Ores, I have discovered in very small quantity on Grassington Moor.*

ZINC, ORES OF.

CALAMINE, Lapis Calaminaris, Zinc mineralised by Oxygen, with or without Carbonic Acid. Compact and stalactitical, raised in considerable quantities in the Liberties of Arncliffe, Kettlewell, and several others in that neighbourhood ; and at Malham, Lord Ribblesdale's Liberty. There is also found at or near Malham, an Oxide of Zinc, in form of a white powder ; some of it is rich ; this has not been met with in any other part of England that I know of.

COAL.

A thin bed of Coal is found on Grassington Moor and other places in that neighbourhood.

The above-mentioned Ores are accompanied in the Vein with Baroselenite (Cank of some), Calcareous Spar, or Carbonate of Lime and Quartz, &c.

* "I myself know two places in Craven, in the West Riding of Yorkshire, where formerly good Silver Ore hath been gotten ; the one is a place called Brungill Moor, in the parish of Slaidburn, where between 50 and 70 years since Sir Bevis Bulmer got good store of Silver Ore that held about 67 pound *per* ton, as Walter Basby, an expert Essay or Test Master, who was at least a person of 76 years of age, and had, as an expert Artist, been in the time of King James sent to the Emperor of Russia to settle the standard of his coin, where he remaining divers years, and going down to the borders of Tartaria to view the Mines there, was taken prisoner by the Tartars, and after redeemed by the Russian Emperor, and sent over into England, where after about the year 1655 he was again brought down by some Londoners that then had a Patent for Mines. But they being then neither of free purses to follow such a work, nor of skill or government fit to follow such an enterprize, they at last deserted the poor old man, whom I entertained for three quarters of a year, and got some of the Ore picked forth of the old rubbish of the works that Sir Bevis Bulmer had left, and caused him to make several trials, &c. The other place was within the Township of Rimington, in the parish of Gisburne in Craven, in a field called Skelkorn belonging to one Mr. Pudsey, an antient Esquire, and owner of Bolton Hall juxta Bowland, who in the reign of Queen Elizabeth, did get there good store of Silver Ore, and converted it to his own use, or rather coined it, as many do believe, there being many shillings marked with an escalop, which the people of the Country call Pudsey's shillings to this day. It yielded in the ton about 26 pounds."

